Policymaker Expectations and Fiscal Policy*

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Abstract

How do policymaker expectations shape fiscal policy? We study this question using British Treasury revenue forecasts, an underexploited source of information on policymakers' economic outlook. Extracting this information requires separating common macroeconomic expectations from tax-specific variation. We develop a Bayesian dynamic factor model to recover these expectations, drawing on a previously unused Treasury exercise that quantified how individual tax revenues respond to economic activity. The recovered expectations capture pessimism surrounding the return to gold, the deterioration in policymakers' outlook during the Great Depression, and its improvement as the economy recovered. Tax policy is estimated to have responded systematically to this changing outlook, with deteriorating expectations prompting tax increases and improving expectations prompting tax cuts. These tax changes had sizeable effects on economic activity, with an estimated first-year tax multiplier of -2.1. A counterfactual suggests that the policy response amplified the Great Depression.

JEL codes: C11, C32, E27, E62, E66, N14

Keywords: policymaker expectations, revenue forecasts, fiscal policy, Bayesian dynamic factor models, fiscal multipliers

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1 Introduction

Fiscal policy is inherently forward looking. Decisions about taxation, spending, and borrowing depend not only on current economic conditions but also on policymakers' expectations of what lies ahead. Yet these expectations are rarely observed directly, particularly in historical settings where policymakers did not produce or publish macroeconomic forecasts. Revenue forecasts offer a window into policymakers' outlook because tax receipts depend systematically on aggregate income, profits, consumption, trade, and prices. Stronger expected growth should therefore translate into stronger revenue forecasts, while a recession should imply weaker receipts.

This paper recovers fiscal policymakers' latent expectations of future macroeconomic conditions from a rich panel of British Treasury revenue forecasts from the interwar period. Individual tax forecasts reflect not only aggregate macroeconomic expectations but also tax-specific institutional features and idiosyncratic shocks. We use a dynamic factor model to extract their common component, but the resulting factors do not in themselves have an economic interpretation. They are identified only up to an arbitrary scale, sign, and rotation (Stock and Watson, 2016).

Our identification strategy exploits a unique archival discovery. In 1923, the Treasury conducted an internal simulation quantifying how forecasts for individual taxes would respond to a hypothetical increase in economic activity. We use this evidence to construct informative priors for a Bayesian dynamic factor model, allowing the latent factors to be interpreted as policymakers' macroeconomic expectations. This provides a novel way to combine archival evidence with latent-variable methods to recover otherwise unobserved expectations from administrative data.

Estimating the model on interwar British Treasury revenue forecasts yields a measure of policymaker expectations that captures the return to gold, the Great Depression, and subsequent recovery. We exploit differences between specific and ad valorem taxes to decompose these expectations into real growth and inflation. The deterioration surrounding the return to gold in 1925 is predominantly associated with deflationary expectations, while recovery from the Depression coincides with a shift to inflationary expectations. By 1936, policymakers remained optimistic about real growth even as inflation expectations declined. Revised revenue forecasts from the Emergency Budget of September 1931 provide a rare within-year measure and reveal a sharp deterioration in the outlook following the April Budget. These results show that revenue forecasts contain rich information about policymakers' evolving economic outlook.

The *Financial Statements* contain information not only on revenue forecasts but also on the tax measures proposed in each Budget. This allows us to examine how policymakers acted on the expectations we recover and how those decisions affected the economy. Exploiting the timing of the budgetary process in a Structural Vector Autoregression, we estimate that tax policy responded systematically to policymakers' changing outlook, with deteriorating expectations prompting tax increases and improving expectations prompting tax cuts. This relationship is particularly pronounced during the Great Depression, when deteriorating expectations account for a substantial part of the tax increases in 1930 and 1931. Extending the VAR to include real GDP growth, we find that tax increases reduce economic activity, with an estimated first-year tax multiplier of -2.13. A counterfactual that shuts down the tax-policy response to expectations

suggests that this response amplified the Great Depression.

Our analysis makes two contributions. First, we develop a new approach to recovering historical policymaker expectations when conventional macroeconomic forecasts are unavailable. Combining administrative forecasts with archival evidence on how policymakers believed revenues responded to economic activity allows us to recover expectations embedded in the policymaking process itself. Second, we contribute to the growing literature on historical fiscal policy. Narrative approaches have identified discretionary tax changes and documented the institutions within which they were made (Romer and Romer, 2010; Cloyne, 2013; Cloyne et al., 2024), and a related macroeconomic literature has examined inflation expectations during the interwar period and their implications for economic activity (Hamilton, 1992; Cecchetti, 1992; Voth, 1999; Ellison et al., 2024). We bring these strands of research together by reconstructing the expectations underlying fiscal decisions, allowing us to trace the link from policymakers' economic outlook through discretionary tax policy to economic activity.

The remainder of the paper is organised as follows. Section 2 describes the Treasury revenue forecasts and their role in the budgetary process. Sections 3 and 4 develop the Bayesian dynamic factor model and use the 1923 Treasury simulation to identify policymaker expectations. Section 5 presents the baseline estimates, and Section 6 interprets them in historical context. Section 7 decomposes expectations into real growth and inflation, while Section 8 incorporates revised forecasts from the Emergency Budget of September 1931. Section 9 examines how tax policy responded to policymaker expectations. Section 10 considers the macroeconomic consequences and constructs a counterfactual path for GDP without the tax-policy response to expectations. Section 11 concludes.

2 Revenue Forecasts

Macroeconomic forecasting did not emerge in the United Kingdom until the 1950s (Hawkins, 2005). Fiscal forecasts, however, have accompanied the Budget since the 1870s. Throughout this period, successive Chancellors, from William Gladstone in the Victorian era to Neville Chamberlain in the interwar period, pursued two principal peacetime fiscal objectives: limiting the size of government and maintaining a balanced budget (Cloyne et al., 2024). To implement this "Minimal Balanced Budget Rule," the Treasury prepared one-year-ahead forecasts of government revenue and expenditure, which guided Budget policy. Projected surpluses permitted tax cuts, whereas projected deficits required tax increases. The Treasury published these forecasts in the *Financial Statement* accompanying the Budget.

The revenue forecasts resulted from discussions among the revenue departments (Inland Revenue and Customs and Excise), the Chancellor, and the Treasury.[1] In normal years, preparation accelerated in March before publication with the Budget in April (Middleton, 1985, p. 69). The

[1] According to Middleton, "while the revenue departments were very definitely junior partners in the budgetary process, their role was not completely passive, and on occasion, they could be an important influence on events. In the shaping of budgetary policy, Inland Revenue's contribution greatly surpassed that of Customs and Excise, whilst in addition, Customs and Excise were more frequently subject to Treasury directives about their estimates and were in a generally weaker position than Inland Revenue" (Middleton, 1985, p. 61).

forecasts were highly detailed. For each tax in force during the interwar period, the Treasury produced two forecasts: one based on existing taxation and one incorporating the Budget's proposed tax changes. The forecasting exercise drew on rich administrative data and detailed knowledge of both the tax system and the economy. For example, the Inland Revenue conducted annual surveys of thousands of firms to estimate profits subject to Income Tax (TNA, IR 63/124) and used the "mortality tables of the Government Actuary" to estimate how many millionaires would remain liable for Super Tax in future years (TNA, IR 64/73).

Figure 1 reproduces the revenue forecast for 1924-25 published on 29 April 1924. Although Chancellors occasionally exerted pressure on the forecasts, parliamentary scrutiny and market discipline limited the scope for manipulation.[2] The Treasury's forecasts were reasonably accurate, despite the volatility of the interwar period. The root mean squared forecast error (RMSE) of revenue outturns relative to forecasts based on new taxation was 2 percentage points, and there was no systematic tendency to overestimate or underestimate revenue.

[2]Winston Churchill, for example, was seemingly a bit looser with the figures than other chancellors: "The departmental estimate of the Exchequer receipt of Income Tax for 1926 was £m252.5 which was rounded up to £m253, and was subsequently increased by the Chancellor to £255m" (TNA, IR 113/25).

	Receipts in 1923–24.	Estimate for 1924–25 on Basis of existing Taxation.	Estimate for 1924–25 more (+) or less (—) than Receipts in 1923–24.
	£	£	£
Customs	119,958,000	127,500,000	+ 7,542,000
Excise	147,970,000	140,000,000	— 7,970,000
	267,928,000	267,500,000	— 428,000
Motor Vehicle Duties	14,691,000	15,600,000	+ 909,000
Estate, &c. Duties	57,800,000	56,000,000	— 1,800,000
Stamps	21,570,000	21,000,000	— 570,000
Land Tax, House Duty and Mineral Rights Duty	2,760,000	3,000,000	+ 240,000
Income Tax	269,331,000	265,000,000	— 4,331,000
Super Tax	60,640,000	61,000,000	+ 360,000
Excess Profits Duty, &c.	—	8,000,000	+ 8,000,000
Corporation Profits Tax	23,340,000	22,000,000	— 1,340,000
	435,441,000	436,000,000	+ 559,000
TOTAL RECEIPTS FROM TAXES £	718,060,000	719,100,000	+ 1,040,000
Postal Service	32,840,000	33,250,000	+ 410,000
Telegraph Service	5,570,000	5,500,000	— 70,000
Telephone Service	14,390,000	15,250,000	+ 860,000
	52,800,000	54,000,000	+ 1,200,000
Crown Lands	920,000	900,000	— 20,000
Interest on Sundry Loans	12,607,000	12,250,000	— 357,000
Miscellaneous:—			
Ordinary Receipts	15,981,000	11,850,000	— 4,131,000
Special Receipts	36,801,000	30,000,000	— 6,801,000
TOTAL RECEIPTS FROM NON-TAX REVENUE £	119,109,000	109,000,000	— 10,109,000
TOTAL REVENUE £	837,169,000	828,100,000	— 9,069,000

Figure 1: Revenue forecasts for fiscal year 1924-25 made in April 1924

3 Modelling Revenue Forecasts

Policymaker expectations of macroeconomic conditions are most directly reflected in revenue forecasts on the basis of existing taxation. Unlike revenue forecasts that incorporate the Budget's proposed tax changes, they are not confounded by discretionary tax changes implemented in response to policymakers' changing perceptions of the economy. Forecasts on the basis of existing taxation therefore provide the cleanest route to identifying policymaker expectations. Our empirical primitive τ_t^i is forecast revenue growth in tax category i for the upcoming fiscal year t on the basis of existing taxation, measured relative to receipts in the previous fiscal year:

$$\tau_t^i = \frac{\text{revenue forecast for tax } i \text{ in fiscal year } t \text{ on the basis of existing taxation}}{\text{receipts for tax } i \text{ in fiscal year } t-1} - 1.$$

In Figure 1, the revenue forecast for Income Tax in 1924-25 on the basis of existing taxation and the receipts for Income Tax in 1923-24 imply $\tau_{1924}^{Income\ Tax} = 265000000/269661000 - 1 = -1.6\%$.

We employ the standard dynamic factor model (DFM) of Stock and Watson (2016) to interpret revenue forecasts over tax categories and time. Let X_t denote the $n \times 1$ vector of revenue forecasts $\{\tau_t^i\}_{i=1}^n$ in year t. The DFM assumes that these forecasts are driven by q unobserved common factors f_t and idiosyncratic components e_t that capture tax-specific variation. Serial correlation is permitted in the common factors, whereas the idiosyncratic components are assumed to be serially uncorrelated. The relationship between the observed forecasts and the latent factors is described by the $n \times q$ lag-polynomial matrix $\lambda(L)$, while the factors evolve according to the $q \times q$ lag-polynomial matrix $\Psi(L)$. The $q \times 1$ vector of innovations to the latent factors is denoted by η_t, assumed to be mean-zero and serially uncorrelated. Formally,

$$X_t = \lambda(L) f_t + e_t, \tag{1}$$

$$f_t = \Psi(L) f_{t-1} + \eta_t. \tag{2}$$

The DFM decomposes revenue forecasts into common and idiosyncratic components. As is well known, only the product $\lambda(L)f_t$ is identified; the common factors f_t are therefore defined only up to an arbitrary scale, sign, and rotation (Stock and Watson, 2016). To interpret the common factors as policymaker expectations, we require additional identifying assumptions.

4 Identifying Policymaker Expectations

Our identification strategy draws on an extensive documentary record detailing the preparation and publication of Treasury revenue forecasts. Many taxes were viewed as procyclical. Income Tax, for example, was regarded by the Chancellor as a "barometer of national prosperity" (Hansard, 14 April 1930, col. 2660). Similarly, internal Inland Revenue correspondence suggested that stronger economic activity would increase Stamp Duty receipts by stimulating stock exchange activity, company transactions, and other business subject to stamp duty (TNA, IR 113/14). By contrast, Estate Duties were viewed as countercyclical because officials expected economic

expansions to raise interest rates, lowering bond prices while raising share prices, with the net effect of reducing receipts (TNA, IR 113/14). Other taxes were regarded as broadly acyclical, with the Inland Revenue concluding for Land Tax receipts that "no improvement of trade will have an appreciable effect" (TNA, IR 113/14).

Knowledge of how policymakers perceived the relationship between economic activity and revenue forecasts already provides an informal route to identification. In a one-factor model, we can normalise the common factor so that it is positively correlated with policymaker expectations of growth in economic activity. Under this normalisation, we would expect the corresponding loadings in the lag-polynomial matrix $\lambda(L)$ to be positive for Income Tax and Stamps, negative for Estate Duties, and close to zero for Land Tax. A novel archival discovery, however, provides an even more direct route to identification than these informal sign restrictions.

In October 1923, the Chancellor of the Exchequer received the results of a simulation prepared jointly by the Inland Revenue and the Intelligence Branch of Customs and Excise.[3] The exercise quantified the effect on revenue forecasts of a hypothetical 25% increase in real economic activity. Crucially for our purposes, the simulation links assumptions about economic activity to revenue forecasts for individual taxes, providing a direct mapping that we can invert to recover policymaker expectations. The underlying scenario assumed that the hypothetical increase in economic activity was driven by a demand shock, allowing for "a more complete employment of the factors of production that exist." It further assumed that the improvement would be rapid, beginning in early 1924 and reaching its full extent by the spring of 1925. Consistent with a demand-driven expansion, wholesale and retail prices were expected to rise, with the wholesale price index increasing from 158 to 200 and the retail price index from 175 to 200.[4]

The blue lines in Figure 2 plot the Treasury's simulation. The top row presents the conditioning assumptions, showing how a 25% increase in real activity in the first panel is accompanied by higher retail prices in the second and higher nominal activity in the third.[5] Consistent with their perceived procyclicality, Income Tax, Super Tax, Corporation Profits Tax, Stamps, and Customs and Excise all increase with economic activity, although the magnitude and timing of the responses vary across taxes. This variation reflects institutional and administrative features of the tax system. For example, before 1927, income and surtax liabilities were assessed on average income over the preceding three years (Middleton, 1985, p. 66). Consistent with their perceived countercyclicality, Estate Duties decline as economic activity increases.

[3]The simulation and associated discussion are from TNA (IR 113/14).

[4]The simulation assumed away nominal rigidities, with prices and output adjusting at the same pace. Other assumptions included constant real wages and unchanged fiscal policy.

[5]The paths between 1922 and 1924 are shown as dashed lines because the simulation specifies only that the recovery in real activity would be "rapid," without defining its precise timing.

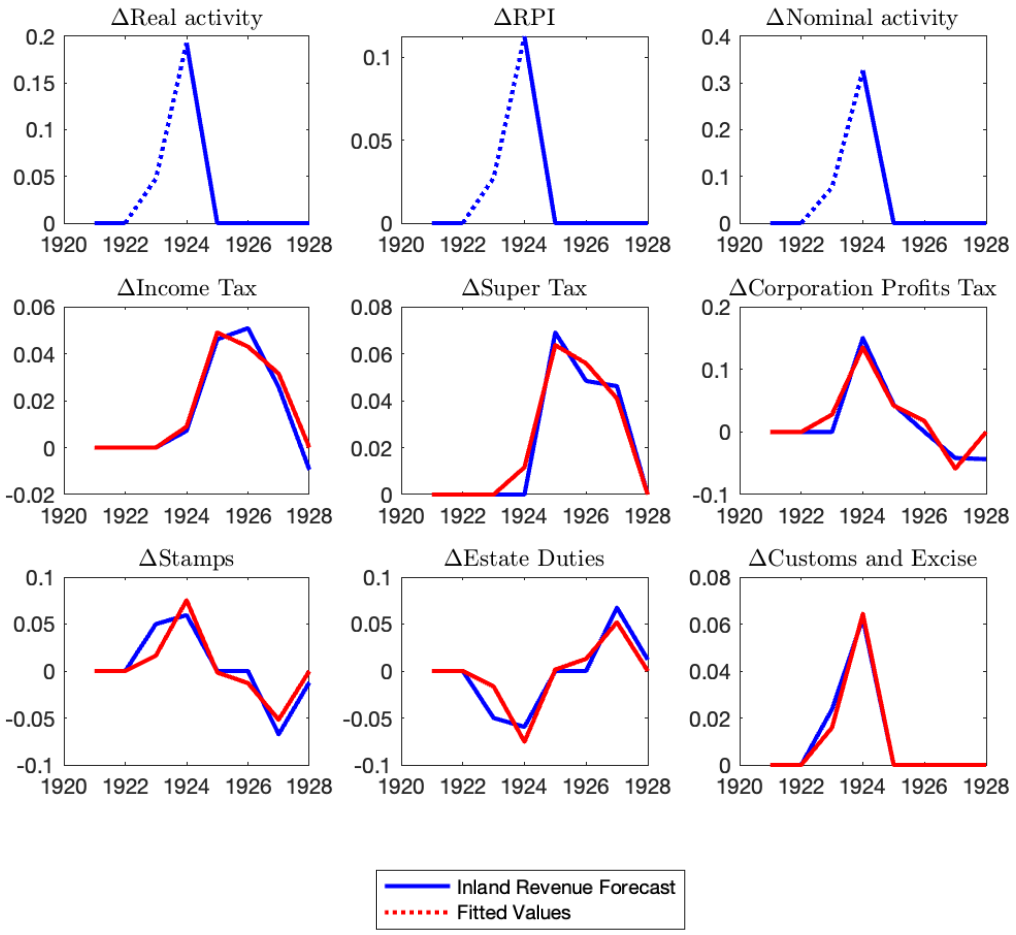


Figure 2: Treasury simulation of effects of 25% increase in economic activity

We match the revenue forecasts in Figure 2 by optimising the elasticities in a parsimonious low-dimensional framework that captures Treasury thinking. With only seven elasticity parameters and a single auxiliary parameter[6], we are able to explain at least 90% of the responses of Income Tax, Super Tax, Corporation Profits Tax, and Excise Duties, and 80% of those of Stamp Duty and Estate Duties. The parameters are chosen to minimise the sum of squared residuals between Treasury forecasts (blue) and fitted values (red), as illustrated in Figure 2.

Changes in Income Tax revenue are well described by the average change in economic activity over the previous three years, with an elasticity of 0.27. Super Tax follows the same pattern but with a larger elasticity of 0.35. Corporation Profits Tax responds positively to the average change in economic activity over the coming year and previous two years, with an elasticity of 0.82, and negatively to the corresponding average over the previous three years, with an elasticity of -0.48. This is consistent with an accelerator effect, whereby tax revenue depends in part on the second derivative of economic activity. Stamps exhibit similar accelerator dynamics, albeit with smaller elasticities of 0.48 and -0.42. The Treasury expected the effect on Estate Duties to broadly offset that on Stamp Duty, implying equal-magnitude, opposite-sign elasticities

[6]The auxiliary parameter is the level of economic activity in 1924, which our optimisation routine estimates to be 4.6% above that in 1923. It is the basis for the dashed blue line in the top row of Figure 2.

for Estate Duties. Finally, changes in Customs and Excise Duties depend only on changes in economic activity in the coming year, with an elasticity of 0.33.

The forecast-matching exercise provides information about the structure and coefficients of the lag-polynomial matrix $\lambda(L)$, which maps the common factor f_t into revenue forecasts in the dynamic factor model (1)–(2). We adopt the timing structure identified by the matching exercise but, rather than treating the matched elasticities as precise estimates of the underlying elasticities in the dynamic factor model, use them as priors in a Bayesian estimation. This allows the historical evidence from the matching exercise to inform the estimation without requiring the matched elasticities to hold exactly. Posterior elasticities are determined jointly by both the prior information and the observed data.

Equation (3) summarises the timing structure. In the first row, changes in Income Tax depend on the average change in economic activity over the previous three years, with a zero contemporaneous elasticity and a common elasticity at lags 1, 2, and 3. The next three rows allow for accelerator dynamics in Estate Duties, Stamps, and Corporation Profits Tax through both contemporaneous and lagged changes in economic activity. The remaining tax categories are linked only to the contemporaneous change in economic activity, either because this is implied by the matching exercise (Customs, Excise) or because there is no explicit evidence to suggest otherwise (Land Tax, Motor Vehicle Duties, Post Office, and Crown Lands).

$$\lambda(L) = \frac{1}{3}\begin{pmatrix} 0 & \lambda_{1,1} & \lambda_{1,1} & \lambda_{1,1} \\ \lambda_{2,0} & \lambda_{2,0}+\lambda_{2,1} & \lambda_{2,0}+\lambda_{2,1} & \lambda_{2,1} \\ \lambda_{3,0} & \lambda_{3,0}+\lambda_{3,1} & \lambda_{3,0}+\lambda_{3,1} & \lambda_{3,1} \\ \lambda_{4,0} & \lambda_{4,0}+\lambda_{4,1} & \lambda_{4,0}+\lambda_{4,1} & \lambda_{4,1} \\ 3\lambda_{5,0} & 0 & 0 & 0 \\ 3\lambda_{6,0} & 0 & 0 & 0 \\ 3\lambda_{7,0} & 0 & 0 & 0 \\ 3\lambda_{8,0} & 0 & 0 & 0 \\ 3\lambda_{9,0} & 0 & 0 & 0 \\ 3\lambda_{10,0} & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ L \\ L^2 \\ L^3 \end{pmatrix}; \qquad \begin{matrix} {}_1\text{Income Tax} \\ {}_2\text{Estate Duties} \\ {}_3\text{Stamps} \\ {}_4\text{Corporation Profits Tax} \\ {}_5\text{Land Tax} \\ {}_6\text{Customs} \\ {}_7\text{Excise} \\ {}_8\text{Motor Vehicle Duties} \\ {}_9\text{Post Office} \\ {}_{10}\text{Crown Lands} \end{matrix} \tag{3}$$

Prior distributions for the elasticities in Equation (3) are reported in Table 1. Where the matching exercise provides guidance, prior means are taken directly from the matched elasticities. Prior standard deviations are then chosen to keep the priors informative without being overly restrictive. The prior standard deviation for Income Tax is tighter than for the other taxes, reflecting its perceived role as the "barometer of national prosperity" (Hansard, 14 April 1930). A prior mean of zero is assigned to tax categories for which no additional information is available.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\lambda_{1,1}$	Normal	0.27	0.1	0.33	[0.18,0.48]
$\lambda_{2,0}$	Normal	-0.48	0.2	-0.58	[-0.82,-0.29]
$\lambda_{2,1}$	Normal	0.42	0.2	0.29	[0.04,0.54]
$\lambda_{3,0}$	Normal	0.48	0.2	0.23	[-0.09,0.55]
$\lambda_{3,1}$	Normal	-0.42	0.2	-0.56	[-0.87,-0.25]
$\lambda_{4,0}$	Normal	0.82	0.2	0.87	[0.57,1.22]
$\lambda_{4,1}$	Normal	-0.48	0.2	-0.48	[-0.80,-0.13]
$\lambda_{5,0}$	Normal	0.00	0.2	0.25	[-0.04,0.50]
$\lambda_{6,0}$	Normal	0.33	0.1	0.19	[0.07,0.32]
$\lambda_{7,0}$	Normal	0.33	0.1	0.17	[0.03,0.32]
$\lambda_{8,0}$	Normal	0.00	0.2	-0.01	[-0.16,0.13]
$\lambda_{9,0}$	Normal	0.00	0.2	0.01	[-0.09,0.10]
$\lambda_{10,0}$	Normal	0.00	0.2	0.02	[-0.08,0.14]

Table 1: Prior and posterior distributions of elasticities

The remaining priors for the dynamic factor model are reported in Table 2. Assuming a one-factor AR(1) specification, priors are required for the common factor's autoregressive coefficient and innovation standard deviation, and for the variances of the serially uncorrelated idiosyncratic components. The autoregressive coefficient $\Psi(0)$ is assigned a prior mean of zero and a standard deviation of 0.5. The standard deviation of innovations to the common factor σ_η has a prior mean of 0.5, allowing the common factor to make a substantial contribution to the dynamics of Income Tax forecasts when coupled with the prior mean of 0.27 for the corresponding elasticity, $\lambda_{1,1}$. The variances of the idiosyncratic components all have a prior mean of 0.1, except for Corporation Profits Tax, whose prior mean is higher because the tax was repealed in 1924.[7] The corresponding prior standard deviations are chosen to place greater weight on revenue forecasts judged to most closely reflect economic conditions, namely Income Tax, Customs, and Excise.

[7]The Corporation Profits Tax revenue forecasts in our data largely reflect arrears from earlier liabilities.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\Psi(0)$	Normal	0.0	0.5	0.04	[-0.47,0.49]
σ_η	Inverse Gamma	0.5	1.0	0.17	[0.11,0.22]
$\sigma_{e,1}$	Inverse Gamma	0.1	0.1	0.05	[0.03,0.06]
$\sigma_{e,2}$	Inverse Gamma	0.1	0.2	0.06	[0.04,0.08]
$\sigma_{e,3}$	Inverse Gamma	0.1	0.2	0.08	[0.05,0.10]
$\sigma_{e,4}$	Inverse Gamma	0.3	0.2	0.26	[0.18,0.35]
$\sigma_{e,5}$	Inverse Gamma	0.1	0.5	0.09	[0.05,0.13]
$\sigma_{e,6}$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,7}$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,8}$	Inverse Gamma	0.1	0.5	0.04	[0.03,0.05]
$\sigma_{e,9}$	Inverse Gamma	0.1	0.5	0.02	[0.02,0.03]
$\sigma_{e,10}$	Inverse Gamma	0.1	0.5	0.03	[0.02,0.04]

Table 2: Prior and posterior distributions of other parameters

5 Baseline Results

The period 1924–39 provides a particularly rich setting in which to study UK policymaker expectations and revenue forecasts. It encompasses the short-lived recession of 1926 and the UK's Great Depression of the early 1930s, both identified by Broadberry et al. (2023), and the build-up to the outbreak of the Second World War. Figure 3 reports revenue forecasts based on existing taxation over this period. These are the observables τ_t^i we stack in the vector X_t to estimate the Bayesian dynamic factor model. Series ending before the end of the sample (Corporation Profits Tax and Land Tax) are retained in the estimation, with missing observations simply contributing no information to the posterior distributions.

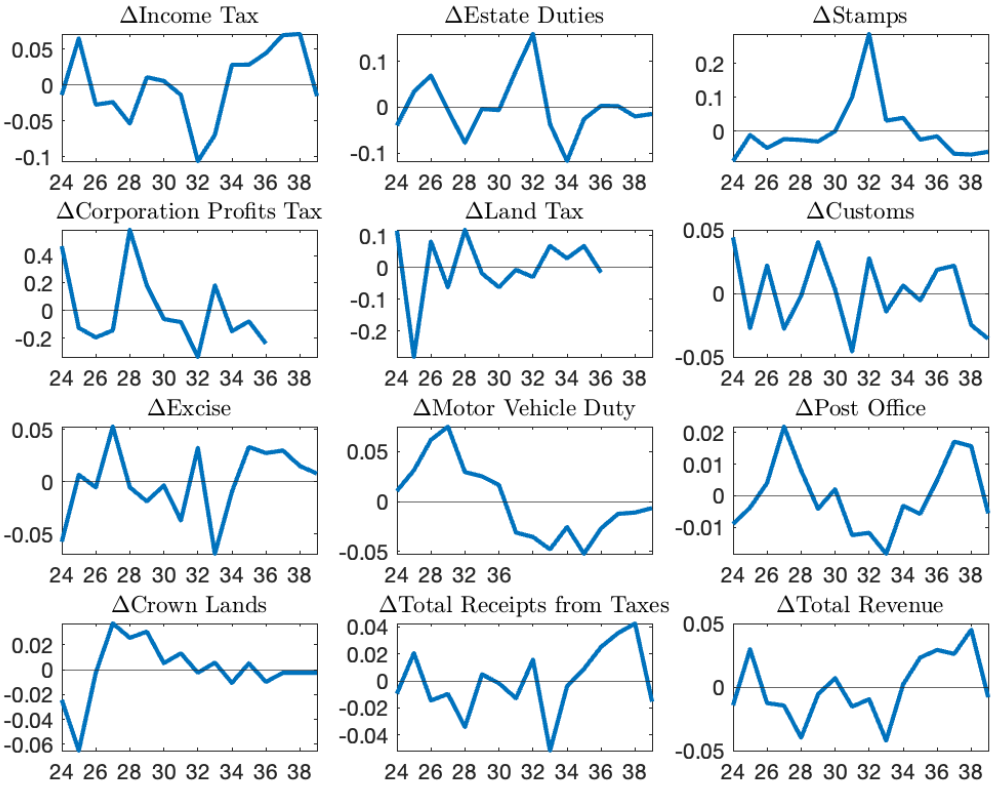


Figure 3: Revenue forecasts on the basis of existing taxation, 1924-39

The state-space model was estimated in Dynare using Bayesian methods. The likelihood of the observed forecasts was evaluated using the Kalman filter and combined with the priors to obtain the posterior distribution of the model parameters. The posterior mode was first obtained by numerical optimisation, after which the posterior was sampled using the Metropolis–Hastings algorithm with 10,000 MCMC replications. The common factor was recovered using the one-sided Kalman-filter estimate, so the filtered factor at each date uses only information available up to that date, conditional on parameters estimated over the full sample. We also construct a historical shock decomposition using the one-sided filtered estimates.

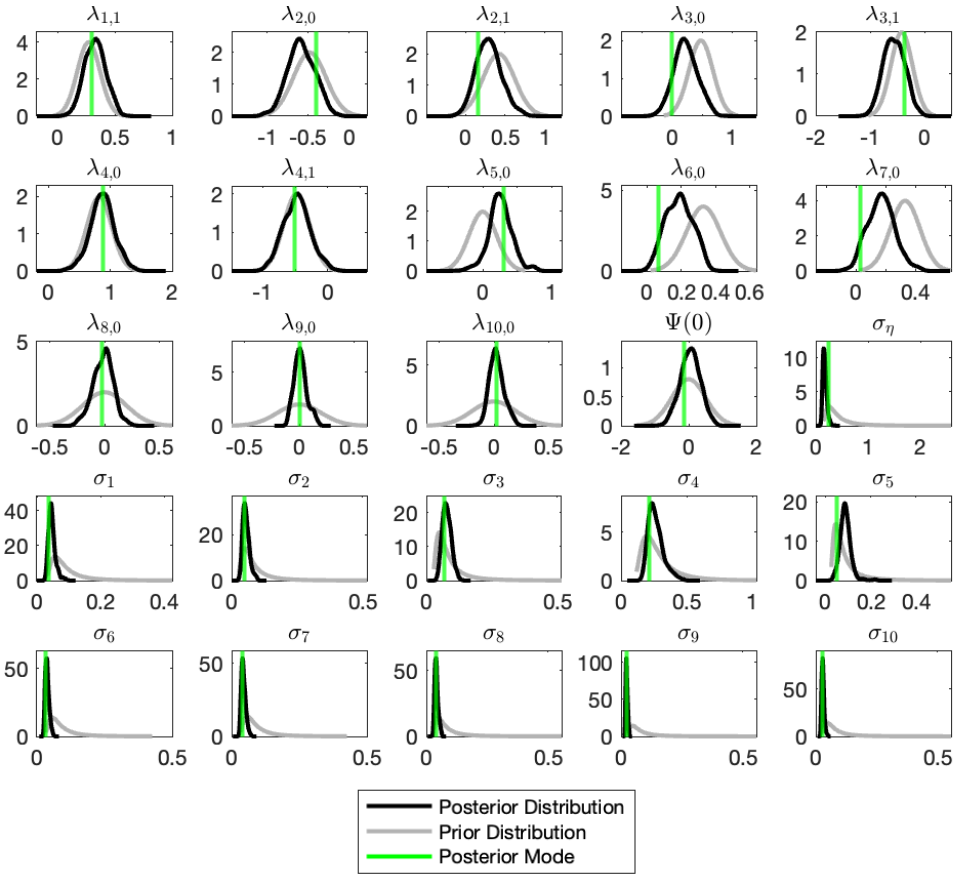


Figure 4: Prior and posterior parameter distributions

The prior and posterior distributions of all parameters are shown in Figure 4, with posterior means and 90% credible intervals appended to Tables 1 and 2. Many posterior means of the elasticity parameters remain close to their prior values, suggesting that the elasticities and timing structure derived from the matching exercise are consistent with the data on revenue forecasts from 1924 to 1939. The credible intervals for the standard deviation parameters indicate that the data are informative about the magnitude of the underlying shocks. By contrast, there is little posterior support for the persistence of the common component. As a robustness check, we re-estimate the model after doubling the standard deviations of the prior distributions. The resulting factor preserves the main movements in our baseline estimate, indicating that its historical pattern is not driven by the informativeness of the priors (Appendix A).

Figure 5 shows the common factor as estimated by the Bayesian state-space model. This is the one-sided filtered estimate, $E_t(f_t \mid \mathcal{I}_t)$.[8] Under the interpretation implied by the priors taken from the matching exercise, it captures policymaker expectations for growth in economic activity over the coming fiscal year. Since the forecasts are made towards the beginning of April each year, the first bar (labelled 24) represents policymaker expectations for the change in economic activity between the beginning of April 1924 and the end of March 1925. The recessions identified by Broadberry et al. (2023) are indicated by grey shading.

[8]The whiskers in Figure 5 are the 25th and 75th percentiles of the estimated distribution of $E_t(f_t \mid \mathcal{I}_t)$.

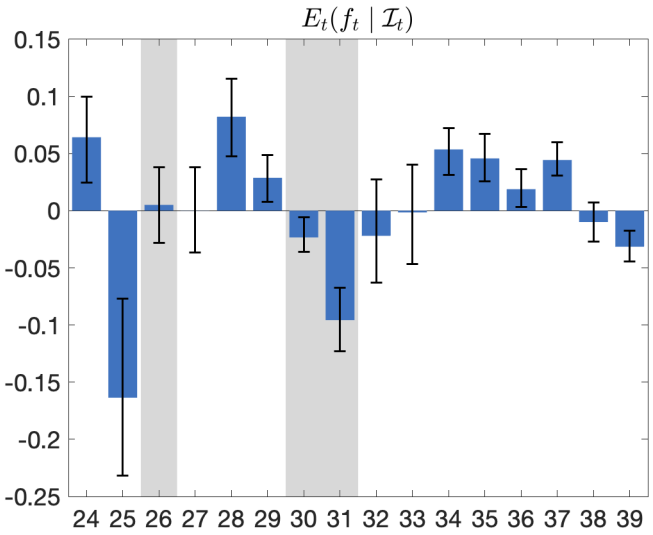


Figure 5: Estimate of the common factor in the Bayesian state-space model

Comparing Figures 3 and 5 reveals an important feature of our results: although the common factor shares some features with the individual revenue forecasts, it is not an obvious transformation of any one series. This reflects the value added by our matching and Bayesian estimation exercise, which draws on forecasts across all tax categories and allows for differences in their timing structures. Our measure of policymaker expectations therefore contains information not apparent from examining individual revenue forecasts in isolation. Indeed, the relationship between the common factor and any individual revenue forecast depends on the timing structure of that tax. For Income Tax, which depends on average economic activity over the previous three years, the resulting historical shock decomposition differs substantially from the path of the factor itself (Appendix Figure A.2). The Forecast Error Variance Decomposition (FEVD) provides a complementary measure of the importance of policymaker expectations. The common factor accounts for 36% of the variation in Income Tax revenue forecasts, 43% for Estate Duties, 31% for Stamps, 8% for Corporation Profits Tax, 25% for Land Tax, 41% for Customs, 29% for Excise, 10% for Motor Vehicle Duties, and 12% for both Post Office and Crown Lands.

6 Interpretation in Historical Context

We now relate our estimates to the historical record to validate and interpret its major fluctuations. To do so, we draw on official contemporary sources and ex-post accounts by economic historians.

The first striking movement in Figure 5 is the sharp deterioration from 1924 to 1925, coinciding with Britain's return to the gold standard at the pre-war parity in April 1925. The decision was consistent with Treasury orthodoxy: officials expected restoration of gold ultimately to support employment by stabilising exchange rates and international trade (Peden, 2000, pp. 191, 198–200). At the same time, they recognised significant short-run adjustment costs. The Chamberlain Committee initially estimated that British prices might have to fall by 10–12 per cent to restore equilibrium at the pre-war parity, although sterling's appreciation reduced the

estimated adjustment to around 6 per cent by January 1925 (Peden, 2000, pp. 197–98). The negative estimate for 1925 is therefore consistent with policymakers supporting the restoration of gold while anticipating difficult economic conditions during the adjustment.

The estimated factor makes a strong recovery in 1928. This brighter outlook is reflected in the Chancellor's budget speech: "Our onward journey is no longer overclouded, and the future finance of this country is freer of difficulty and stringency than in any other Budget which it has been my duty to open" (Hansard, 24 April 1928, col. 874).

Turning to the Great Depression, the estimated factor deteriorates in 1930, reaches a trough in 1931, and remains negative in 1932. The slump was a major macro problem with serious fiscal implications for the government. According to the Statistics and Intelligence Division in late 1930, "Any attempt to forecast the Inland Revenue out-turn for 1930 and estimate for 1931 involves the measurement of two things which at the moment are practically incalculable for revenue purposes: (1) the depth and (2) the duration of the trade depression" (TNA, IR 63/130, 18 December 1930). In the best case scenario, they expected a deficit in 1930-31 of £20.9 million; in the worst case, a deficit of £41.6 million (TNA, IR 63/130, 19 December 1930).

The rebound in our estimated factor suggests that there was a decisive shift to optimism from 1934. This is supported by internal documents. The Inland Revenue were confident that the economy had "definitely turned the corner" (TNA, IR 63/138). The Treasury counted on a continued recovery in its forecast that underpinned the budget of 1934-35: "It is assumed that the improvement in the industrial and commercial situation which has recently been developing will continue unchecked during 1934/35" (TNA, T171/315, 9 March 1934). Closer to budget day, the Treasury confirmed that a "reasonably hopeful view of the future has been taken" (TNA, T171/315, 10 April 1934). As the Chancellor put it in the budget speech: "If I might borrow an illustration from the titles of two well-known works of fiction, I would say that we have now finished the story of *Bleak House* and that we are sitting down this afternoon to enjoy the first chapter of *Great Expectations*" (Hansard, 17 April 1934, col. 906).

The turnaround developed into a sustained period of optimism, with our estimates remaining positive through 1937. Over these years, the economic recovery strengthened, supported by the policy of cheap money. Industrial capital issues increased substantially between 1932 and 1937, while the housing boom contributed significantly to employment growth (Peden, 2000, pp. 258–60). Treasury officials viewed these developments favourably. Peden notes that they were "certainly pleased" with the results of cheap money, and by late 1936 Sir Frederick Phillips, a senior official, expected the price level to reach the Treasury's desired level within a year (Peden, 2000, p. 260). The consistently positive estimates from 1934 to 1937 therefore reflect a period in which policymakers increasingly viewed the recovery as firmly established.

There was a dimming of the economic outlook at the end of the decade as our estimates turn negative in 1938 and 1939. John Simon, the new Chancellor, looking back on the previous year and peering forward to the year ahead, stated to the House of Commons that: "the first six months of the year were more prosperous than the second six months, though the latter were still good, and this is a trend which must be noted in forecasting the immediate future" (Hansard, 26 April 1938, col. 46). As Simon stood at the despatch box a year later, he expected

a decline in revenue in general and in Customs and Excise in particular, explaining: "The main consideration, of course, is that of trade prospects as a whole, as they may be affected by changes in the international situation" (Hansard, 25 April 1939, col. 985).

Taken together, the historical context provides substantial support for our estimated measure of policymaker expectations. Its main fluctuations align with changes in the economic outlook documented in Treasury assessments and the historical record. The estimates capture pessimism surrounding the return to gold, late-1920s optimism, the deterioration during the Depression, gradual but sustained recovery, and renewed pessimism as the war loomed.

7 An Inflation versus Real Growth Decomposition

Our estimate of policymaker expectations captures beliefs about the growth of nominal economic activity over the coming fiscal year. Nominal growth reflects both real growth and inflation, so it would be useful to identify separate expectations for each. Conveniently, the British tax system allows us to do so. Revenues from ad valorem taxes respond directly to both prices and quantities, so forecasts reflect expectations about both inflation and real growth. By contrast, revenues from specific taxes are not directly affected by prices, so their revenue forecasts primarily reflect expectations about real growth. This distinction allows us to identify separate real growth and inflation factors. Ad valorem revenue forecasts reflect the sum of both factors, whereas specific-tax forecasts predominantly reflect the real growth factor.

We examine two principal sources to determine whether individual taxes were ad valorem or specific. The first is the interwar *Financial Statements*, which provide details of any proposed tax changes. We supplement these with the *Twenty-Ninth Report of the Commissioners of His Majesty's Customs and Excise* (1938), which summarises Customs and Excise tax rates at the outbreak of the First World War and their evolution to 1937.

- **Excise duties** were overwhelmingly specific. For example, British beer was subject to a flat duty of £5 per barrel in 1920 (Parliamentary Papers, 1920, p. 8). There were a few minor ad valorem exceptions, which we deduct from the Excise forecasts and outturns.
- **Motor Vehicle Duties** were specific. They were levied on licences for private and commercial "Motor Cars and Motor Cycles" (Parliamentary Papers, 1920, p. 8). Rates varied according to vehicle characteristics such as type, seating capacity, weight, and horsepower (Parliamentary Papers, 1920, pp. 8–9).
- **Post Office revenue** was generated primarily from specific charges. Examples include charges based on the weight of letters and parcels, the number of newspapers delivered, and the number of words in a telegram (Parliamentary Papers, 1920, 1924).[9]

[9] A minor exception was money and postal orders, which were subject to a graduated fee schedule based on the value of the order. For example, in 1920 the inland money order fee increased to 4d. for orders not exceeding £3, 6d. for orders not exceeding £10, and so on (Parliamentary Papers, 1920, p. 15). On average, poundage on money and postal orders accounted for only 3% of total Post Office receipts during the interwar period (Parliamentary Papers, various). We therefore classify Post Office revenue as specific.

- **The remaining taxes** combined specific and ad valorem elements. Unfortunately, the historical evidence provides no basis for disentangling their relative contributions.

Based on this evidence, we distinguish between specific taxes (Excise, Motor Vehicle Duties, and the Post Office) and all other taxes. Revenue forecasts for the specific taxes are assumed to depend only on policymakers' expectations of real growth. Accordingly, we model them using a single factor, $f_t^{\Delta y}$, which captures those expectations. Revenue forecasts for all other taxes are assumed to reflect expectations of nominal growth and are therefore modelled using the sum of the real growth factor and an inflation factor, f_t^{π}. Figure 6 presents the estimated real growth and inflation factors. Full details of the estimation are provided in Appendix B.

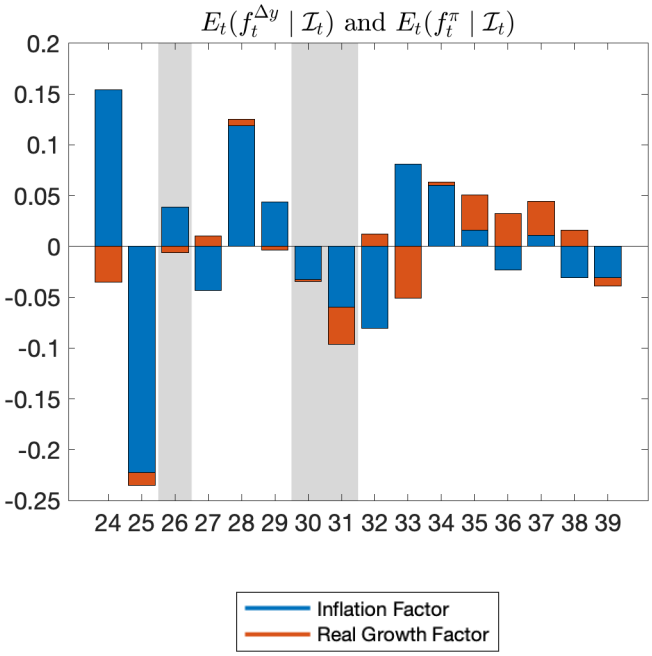


Figure 6: Inflation and real growth factors in the two-factor specification

The decomposition provides further historical validation of our measure of policymaker expectations. The sharp deterioration in 1925 is predominantly driven by the inflation factor, reflecting concerns over the price adjustment required to sustain the restored gold parity. During the Depression, inflation expectations were negative between 1930 and 1932, accounting for the majority of the decline in expectations of nominal economic activity. After leaving the gold standard in September 1931, inflation expectations recovered only gradually, remaining negative in 1932 before turning positive by the spring of 1933. This timing lines up with an alternative measure of inflation expectations derived from commodity futures prices, newspaper reporting, and the term structure of interest rates (Lennard et al., 2023). In 1936, the real growth factor remains positive while the inflation factor turns negative. This pattern matches Phillips' assessment that prices were approaching the Treasury's desired level and that the boom should not become excessive (Peden, 2000, p. 260).

8 The Emergency Budget of September 1931

In September 1931, in response to a perceived worsening of the economic outlook, Chancellor Philip Snowden presented Parliament with a supplementary budget containing revised revenue forecasts for the fiscal year 1931–32. The accompanying *Financial Statement* projected a £25m shortfall in Inland Revenue receipts relative to the forecast presented in April, while Customs and Excise receipts were expected to be £4m lower. The gravity of the situation was reflected in *The Times*, whose leader of 11 September 1931 was titled "An Emergency Budget."

The information in the Emergency Budget can be incorporated into estimates of policymaker expectations by extending the Bayesian state-space model to distinguish between revenue forecasts made in April and September. We use the following specification:

$$X_t^A = \lambda f_t^A + e_t^A, \tag{4}$$

$$X_t^S = \lambda f_t^S + e_t^S, \tag{5}$$

$$f_t^A = \Psi^A f_{t-1}^S + \eta_t^A, \tag{6}$$

$$f_t^S = \Psi^S f_t^A + \eta_t^S. \tag{7}$$

The variables X_t^A and X_t^S denote the April and September revenue forecasts, with f_t^A and f_t^S their corresponding factors. The April factor f_t^A depends on the previous year's September factor f_{t-1}^S with persistence Ψ^A and innovation η_t^A. The September factor f_t^S, in turn, depends on the same year's April factor f_t^A with persistence Ψ^S and innovation η_t^S. Since X_t^S is observed only in 1931, September observations in all other years are treated as missing and provide no information for updating the common factors in the Kalman filter estimation.

An expanded factor structure requires additional priors for the parameters in the equations for the common factors. To inform these priors, we combine Equations (6)–(7):

$$f_t^A = \Psi^A \Psi^S f_{t-1}^A + \Psi^A \eta_{t-1}^S + \eta_t^A. \tag{8}$$

We set the prior mean of Ψ^S to one, so that the September factor inherits the April factor as its baseline. The prior mean of Ψ^A is 0.04. Together, these choices imply a prior mean for the AR(1) persistence parameter in Equation (8) that matches the low persistence between April revenue forecasts reported for the one-factor model in Table 2. Each of the innovations η_t^A and η_t^S is assigned the same prior distribution as the innovation in the one-factor model. This also applies to λ. For tax categories that depend on lagged common factors, revenue forecasts incorporate the most recent estimates of the common factors. For example, the April income tax forecast depends on the average of the September factors from the preceding three years. The priors and estimated posteriors are provided in Appendix C.

Incorporating the revised revenue forecasts from September 1931 leaves the broad pattern of policymakers' expectations largely unchanged, but provides a sharper picture of how expectations evolved during the crisis. In Figure 7, the April-only estimates already indicate pronounced pessimism in 1931, but the September estimate is substantially more negative, confirming that policymakers' outlook worsened markedly in the five months following the April Budget. This

pattern accords closely with contemporary assessments. Presenting the revised estimates in September, Chancellor Philip Snowden observed that "since the Budget Statement in April, the great depression has grown deeper" (Hansard, 10 September 1931, col. 300). Importantly, the additional September information does more than provide a new within-year estimate: because it enters the joint estimation of the model, it also modestly revises the estimated April factors, particularly in 1933. The resulting pattern changes the inferred timing of the shifts in policymakers' expectations over this period, attributing a larger part of the deterioration to the sharp downward revision between April and September 1931.

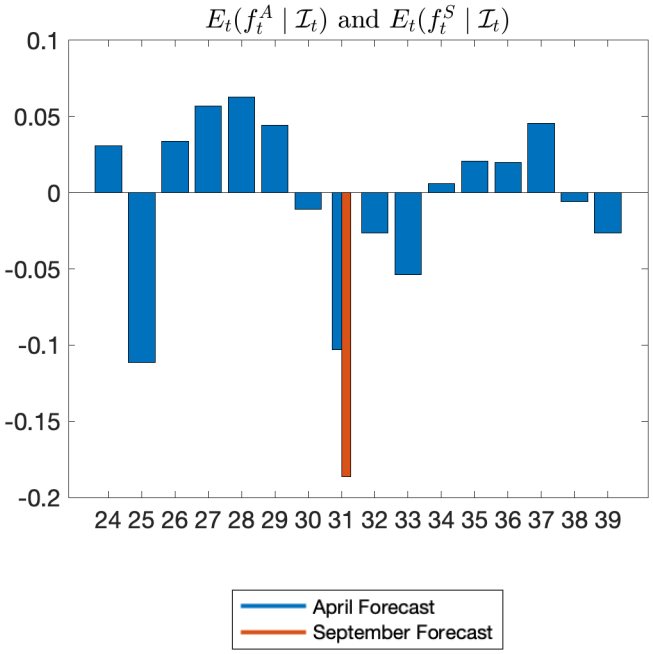


Figure 7: Estimate of the common factor including the September 1931 budget

9 Policymaker Actions

We now turn from expectations to actions: did expectations about future economic activity affect what policymakers did? To answer this question, we exploit the timing of the budgetary process and information on proposed policy changes published in the same *Financial Statements* used to estimate policymaker expectations. Because expenditure was decided in advance of the budget, policymakers faced a predetermined revenue requirement when the *Financial Statements* were published.[10] We can therefore examine how they adjusted policy in response to the expected path of economic activity. Importantly, we observe policymakers' expectations at precisely the time these policy changes were proposed.

As an example of how policymaker actions are recorded in the *Financial Statements*, Figure 8 reports the measures proposed in April 1924 and their individual effects on forecast revenue for 1924–25. The largest was a £17.2 million reduction in Customs revenue from Sugar, Molasses,

[10]The "supply cycle" meant that "Parliament considered expenditure proposals prior to the budget, which was therefore only a tax budget" (Middleton, 1985, p. 51).

Glucose and Saccharin, followed by a £5 million reduction from cutting the Customs Duty on Tea from *8d* to *4d* per *lb*. Read alongside the aggregate revenue forecasts in Figure 1, these estimates allow us to identify how individual policy decisions alter the Budget's revenue forecast.

——	Estimated Loss in 1924–25.	Estimated Loss in a Full Year.
CUSTOMS:	£	£
Tea	5,000,000	5,400,000
Cocoa	580,000	600,000
Coffee	180,000	200,000
Chicory	40,000	43,000
Sugar, Molasses, Glucose and Saccharin	17,200,000	17,880,000
Raisins, Figs and Plums	200,000	250,000
Table Waters and Herb Beer	*	*
New Import Duties	2,500,000	2,750,000
Total Customs	25,700,000	27,123,000
EXCISE:		
Chicory	*	*
Coffee Substitutes	*	*
Sugar, Molasses, Glucose and Saccharin	500,000	520,000
Table Waters and Herb Beer	200,000	300,000
Entertainments	3,400,000	4,000,000
Total Excise	4,100,000	4,820,000
Total Customs and Excise	29,800,000	31,943,000
MOTOR VEHICLE DUTIES	*	500,000
INLAND REVENUE:		
Corporation Profits Tax repealed	2,000,000	12,500,000
Inhabited House Duty repealed	1,750,000	2,000,000
Total Inland Revenue	3,750,000	14,500,000
POST OFFICE	500,000	1,000,000
Total Estimated Loss	34,050,000	47,943,000

* The loss in these cases is negligible.

Figure 8: Effect of proposed policy changes on revenue forecasts for 1924-25

Table 3 extends this exercise across Budgets and separates policymaker actions into three categories. Tax-liability changes alter the underlying tax obligation through changes in rates, allowances, duties, or the tax base. Tax timing measures change when existing tax liabilities are paid, shifting receipts between financial years without an equivalent change in underlying tax liability. Other revenue and account actions comprise non-tax measures that affect forecast revenue, including changes in Post Office receipts and transfers from special accounts or funds. The final column gives the total effect of all policy actions on the Budget-year revenue forecast.

Budget	Tax-liability changes	Tax timing	Other revenue / account action	Total policy action
1924	Customs & Excise −£29.8m; Corporation Profits Tax −£2m; Inhabited House Duty −£1.75m	–	Post Office telephone rates −£0.5m	−£34.05m
1925	Customs & Excise +£4.26m; Estate Duty +£4.5m; Income Tax −£24m; earned-income relief −£3m; Super-tax −£6.7m	–	–	−£24.94m
1926	Customs +£0.75m; Betting duty +£1.5m; Motor Vehicle Duties +£1.5m; Irish double-income-tax agreement −£0.2m	Beer-duty credit period +£5.5m	Sundry loans and miscellaneous receipts +£11m	+£20.05m
1927	Customs +£5.67m; Excise excluding beer timing +£0.31m; Estate Duty +£0.3m; Stamps −£0.2m; other Income Tax changes +£0.1m	Beer-duty credit period +£5m; Schedule A collection in one instalment +£14.8m	Road Fund Reserve +£12m	+£37.98m
1928	Customs & Excise +£12.135m; Motor Vehicle Duties (including Road Fund share) −£0.8m; Income Tax child relief −£2.1m	–	Currency Note Assets +£13.2m	+£22.435m
1929	Customs & Excise −£7.77m; Motor Vehicle Duties (including Road Fund share) −£0.11m	–	Post Office net receipt −£0.09m	−£7.97m
1930	Customs & Excise +£2.57m; Motor Vehicle Duties (including Road Fund share) −£0.11m; Inland Revenue +£31.25m	–	Rating Relief Suspense Account +£16m	+£49.71m
1931 Apr.	Hydrocarbon-oil duty +£7.5m	Income Tax instalment acceleration +£10m	Exchange Account +£20m	+£37.5m
1931 Sept.	Customs & Excise +£11.5m; Income Tax +£25m; Sur-tax +£4m	–	–	+£40.5m
1932	Sugar −£1.1m; tea and other Customs/Excise changes +£3.625m	–	–	+£2.525m
1933	Ordinary tax-liability changes −£11.953m; Motor Vehicle Duties/Road Fund +£1.1m	Income Tax instalment change −£12m	War Loan Depreciation Fund +£10m	−£12.853m
1934	Income Tax rate reduction −£20.5m; Motor Vehicle Duties (including Road Fund share) −£2.245m	–	–	−£22.745m
1935	Customs +£1.02m; Excise −£2.1m; Income Tax allowances −£4.5m; Motor Vehicle Duties/Road Fund −£0.27m	–	Road Fund transfer to Exchequer +£4.47m	−£1.38m
1936	Customs & Excise +£3.525m; Inland Revenue +£13m	–	Road Fund receipt +£5.25m	+£21.775m
1937	Income Tax/Sur-tax +£13.15m; National Defence Contribution +£2m	–	–	+£15.15m
1938	Inland Revenue excluding timing +£24.25m; Customs & Excise +£8.1m	Schedule A collection deferment −£2m	–	+£30.35m
1939	Inland Revenue +£7m; Customs & Excise +£11.02m; Motor Vehicle Duties +£6.25m	–	–	+£24.27m

Notes: Values measure the effect on forecast revenue in the Budget year; positive values raise forecast revenue and negative values reduce it. Tax timing measures shift receipts across financial years without an equivalent change in underlying tax liability. Other revenue/account actions include Post Office measures and transfers or appropriations from special accounts or funds. The components reconcile to the policy-action measure, defined as the new forecast less the forecast on the existing-policy basis. The 1928 oil Excise item and the 1932 tea Excise item are non-recurrent but are retained as tax-liability changes because they impose actual tax liabilities rather than merely changing collection dates.

Table 3: Decomposition of Budget policy actions, 1924–1939

Proposed policy changes provide the evidence needed to assess whether policymakers acted on their expectations. Crucially, the budgetary process places our measure of expectations before policy actions. Policymakers first formed a conjunctural assessment under the assumption of no policy changes, which we recover from the forecasts on an existing-policy basis. Only then did they decide what actions to take, so expectations are predetermined with respect to policy. This timing motivates the identifying restrictions in our Structural Vector Autoregression (SVAR). Since expectations have already been formed when tax measures are decided, tax-policy innovations cannot affect expectations for the same Budget, whereas innovations to expectations can affect the tax measures subsequently proposed. The resulting recursive identification scheme orders expectations before tax policy, allowing structural innovations to be recovered using a Cholesky decomposition.

For the SVAR, we define tax policy as the sum of the first two columns of Table 3. The measure includes both changes in underlying tax liabilities and changes in the timing of those liabilities. We include the latter because they are deliberate tax-policy decisions that alter revenue in the Budget year, even where the underlying tax burden is unchanged. We exclude the third column, which captures non-tax revenue and accounting measures such as Post Office receipts and transfers from special funds. This gives us a measure of discretionary tax policy rather than all policy-induced changes in forecast revenue. The annual sample contains only 16 observations, limiting the dynamics that can be estimated with sufficient degrees of freedom. We estimate a bivariate VAR with two lags. An additional issue arises in 1931, when two Budgets were presented. Since the annual specification requires a single observation for each year, we use September expectations and combine the tax actions from both Budgets. The results are similar when we instead use April expectations and actions.

Let ΔT_t denote the change in forecast revenue implied by the discretionary tax measures proposed in the Budget at date t, and let $\hat{f}_t$ denote policymakers' expectations of growth in economic activity over the coming financial year at the time the Budget is prepared. Our timing convention dates both variables to the financial year beginning with that Budget. The contemporaneous relationship in the SVAR therefore captures the relationship between expectations formed around the beginning of the financial year and tax measures proposed in the same Budget. We estimate the following bivariate Structural Vector Autoregression (SVAR) with two lags:

$$\begin{pmatrix} \hat{f}_t \\ \Delta T_t \end{pmatrix} = \Gamma_0 + \Gamma_1 \begin{pmatrix} \hat{f}_{t-1} \\ \Delta T_{t-1} \end{pmatrix} + \Gamma_2 \begin{pmatrix} \hat{f}_{t-2} \\ \Delta T_{t-2} \end{pmatrix} + \begin{pmatrix} \phi_{ff} & 0 \\ \phi_{\Delta T f} & \phi_{\Delta T \Delta T} \end{pmatrix} \begin{pmatrix} \epsilon_t^f \\ \epsilon_t^{\Delta T} \end{pmatrix}. \tag{9}$$

The Γs and ϕs are parameters to be estimated, while ϵ_t^f and $\epsilon_t^{\Delta T}$ are innovations to expectations and tax policy. Estimation begins with a reduced-form Vector Autoregression (VAR). A Cholesky decomposition then imposes the ordering motivated by the timing above, with expectations preceding tax policy. This rules out tax-policy innovations affecting expectations formed for the same Budget, while allowing innovations to those expectations to affect tax measures proposed in that Budget. Statistical uncertainty is assessed using 10,000 bootstrap replications, incorporating uncertainty from the VAR and the uncertainty associated with estimating the factor $\hat{f}_t$.

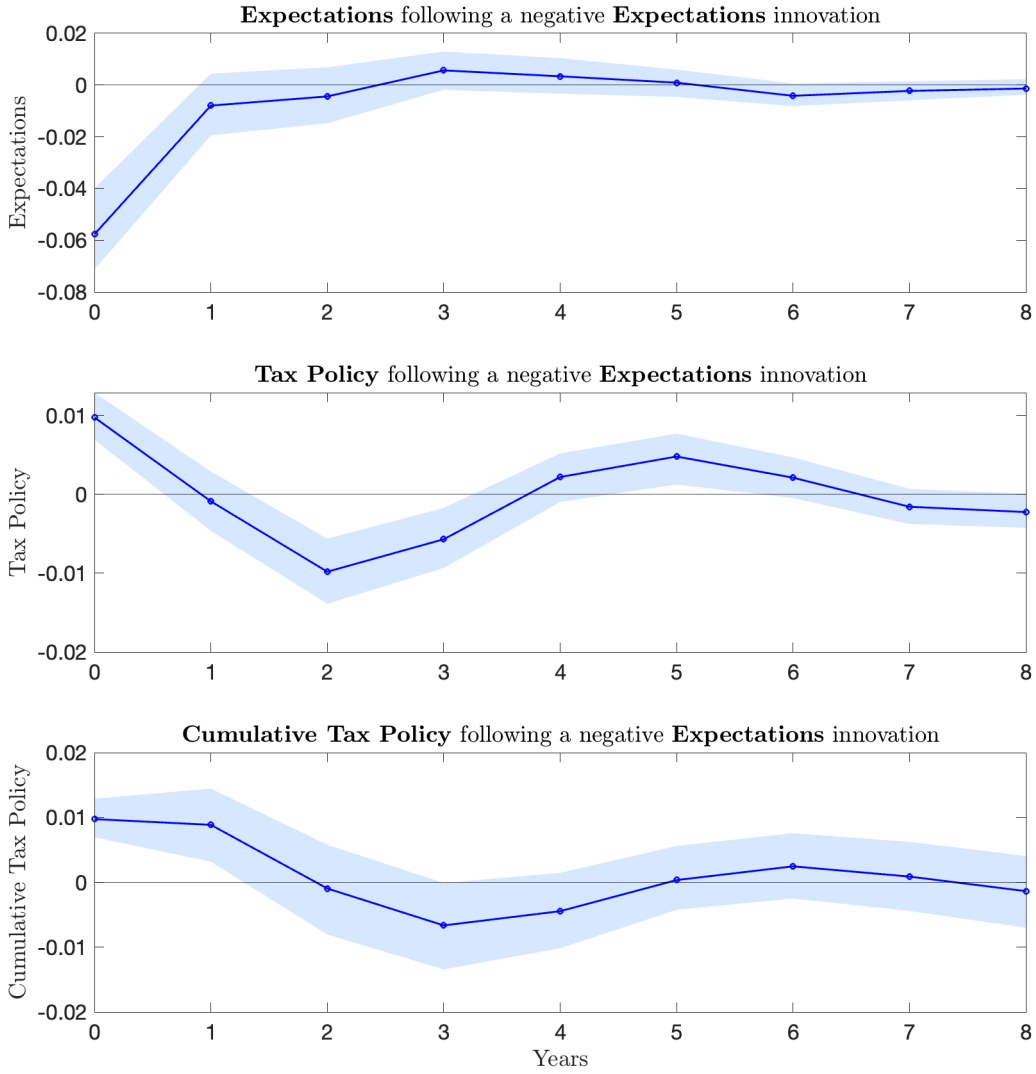


Figure 9: Response to innovation ϵ_t^f to policymaker expectations, 25th to 75th percentiles

Figure 9 reports the responses to a one-standard-deviation deterioration in policymaker expectations, as generated by the bivariate SVAR. The top panel shows expected growth in economic activity over the coming financial year, which falls sharply before gradually returning towards its pre-shock level. The middle panel traces the response of tax policy, measured by the change in forecast revenue implied by discretionary tax measures in each period. The deterioration in expectations is associated with a tax-policy response that raises forecast revenue in the same Budget and again in the following financial year, before the response weakens and subsequently changes sign. The bottom panel shows the cumulative revenue implications of these tax-policy responses. The cumulative increase is positive over the first two financial years, although the bootstrap interval is relatively wide. Taken together, the panels show that deteriorating expectations are associated with revenue-raising tax policy both in the Budget in which the deterioration is observed and in the following financial year.

The impulse responses accord closely with the historical pattern of tax actions in Table 3. The clearest example is the Depression. Policymaker expectations deteriorated sharply in 1930 and

reached their Depression-era trough in 1931, precisely when tax policy shifted strongly towards raising revenue. The 1930 Budget introduced tax measures that increased forecast revenue by £33.71 million, while the April and September 1931 Budgets raised it by a further £17.5 million and £40.5 million respectively. Snowden's statement in September that "the great depression has grown deeper" provides contemporary evidence that the latter measures were taken against a sharply worsening outlook. The opposite pattern is visible as expectations began to recover. Tax measures reduced forecast revenue by £22.853 million in 1933 and £22.745 million in 1934, the latter including a *6d* reduction in the standard rate of Income Tax. The historical record therefore mirrors the impulse responses, with weaker expectations associated with revenue-raising tax policy and stronger expectations with revenue-reducing tax policy.

Figure 10 reports the responses to a one-standard-deviation innovation to tax policy that raises forecast revenue. The bottom panel shows that the revenue increase is concentrated in the Budget in which the tax-policy innovation occurs, with smaller tax-policy responses in subsequent years. The top panel shows the response of expected growth in economic activity. By construction, expectations formed for that Budget do not respond to the tax-policy innovation, reflecting the ordering of the budget process in which expectations are formed before tax measures are decided. Expectations subsequently decline, although the magnitude of the fall is poorly estimated. The results suggest that revenue-raising tax policy unrelated to prior expectations may have led policymakers to revise down their expectations of future economic activity.

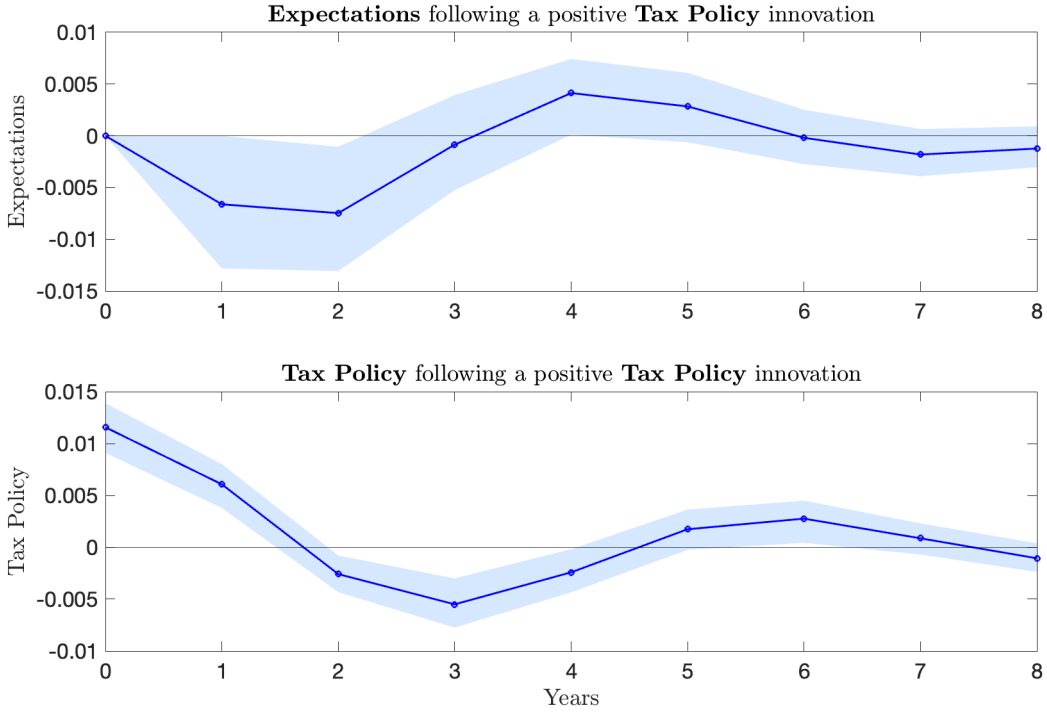


Figure 10: Response to innovation $\epsilon_t^{\Delta T}$ to tax policy 25th to 75th percentiles

We can also use the bivariate SVAR to assess the historical importance of the tax-policy response to changes in policymaker expectations. For each year, we use the identified innovations to expectations and the estimated impulse responses to recover their contribution to tax policy.

Figure 11 decomposes observed tax policy into this expectation-induced component and a residual reflecting other influences on policy. The decomposition is particularly striking around the Depression. Deteriorating expectations account for a substantial part of the revenue-raising tax policy in 1930 and 1931, with the expectation-induced component especially large in 1931. As expectations recover, this pattern reverses, with the expectation-induced component reducing forecast revenue between 1932 and 1934. The decomposition thus reinforces the historical evidence above that the shift towards revenue-raising tax policy in 1930–31 was closely connected to the deterioration in policymakers' economic outlook.

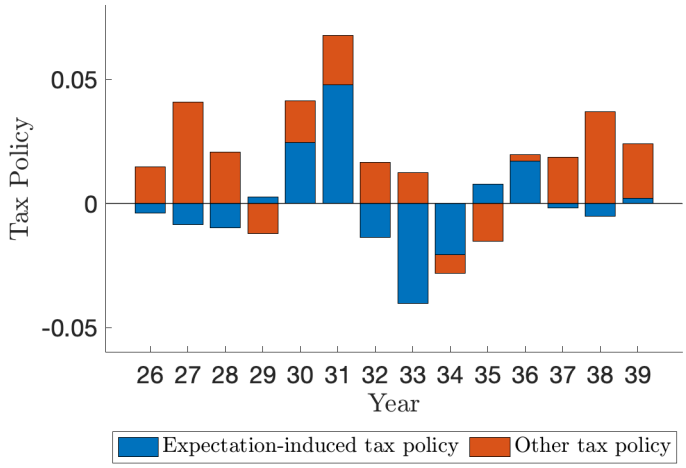


Figure 11: Decomposition of tax policy into expectation-induced and other components

10 Macroeconomic Consequences

Having found evidence that tax policy responds to changes in policymaker expectations, we now ask whether this response mattered for the macroeconomy. Answering this question is challenging in a data-poor historical setting. We nevertheless extend the bivariate VAR by incorporating real GDP growth, allowing us to trace the transmission from policymaker expectations through tax policy to real economic activity. Adding a third endogenous variable substantially increases the number of parameters. Given the limited sample, we reduce the lag length from two to one to preserve degrees of freedom while allowing for dynamics in all three variables. Real GDP is measured using quarterly estimates from Mitchell et al. (2012), aggregated to the April–March financial year to align with the timing of the Budget and revenue forecasts.

We build on the recursive identification of Section 9 by exploiting the within-year timing of expectations, tax policy, and economic outcomes. Policymaker expectations are formed and tax policy is set at the beginning of the financial year, before GDP growth is realised. We therefore order real GDP growth after expectations and tax policy. This allows innovations to expectations and tax policy at the beginning of the financial year to affect GDP growth over that financial year, while ruling out innovations to GDP growth over the year affecting

expectations or tax policy that have already been set. Structural innovations are recovered using a Cholesky decomposition, and statistical uncertainty is assessed using 10,000 bootstrap replications that account for uncertainty in the expectations factor. With g_t denoting real GDP growth in financial year t,

$$\begin{pmatrix} \hat{f}_t \\ \Delta T_t \\ g_t \end{pmatrix} = \Gamma_0 + \Gamma_1 \begin{pmatrix} \hat{f}_{t-1} \\ \Delta T_{t-1} \\ g_{t-1} \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ \gamma \end{pmatrix} D_{1926,t} + \begin{pmatrix} \phi_{ff} & 0 & 0 \\ \phi_{\Delta T f} & \phi_{\Delta T \Delta T} & 0 \\ \phi_{gf} & \phi_{g\Delta T} & \phi_{gg} \end{pmatrix} \begin{pmatrix} \epsilon_t^f \\ \epsilon_t^{\Delta T} \\ \epsilon_t^g \end{pmatrix}. \tag{10}$$

The zero restrictions in the impact matrix reflect the recursive timing assumptions. The zero in the first row of the second column follows from the ordering of expectations before tax policy in Section 9: tax-policy innovations cannot affect expectations that have already been formed for that Budget. The two zeros in the third column reflect the additional timing restriction that innovations to GDP growth over the financial year cannot affect expectations or tax policy set at its beginning.[11] We also include a dummy, $D_{1926,t}$, equal to one in 1926 and zero otherwise, in the GDP equation to account for the exceptional disruption to economic activity associated with the General Strike.

Figure 12 reports the responses of real GDP growth to the structural innovations identified by the trivariate VAR. A deterioration in policymaker expectations at the beginning of the financial year reduces GDP growth over that financial year, but the effect dissipates quickly. A revenue-raising tax-policy innovation similarly reduces GDP growth over the financial year, with the effect persisting into the following year before fading. An innovation in GDP growth raises growth in the same financial year, but the effect is short-lived. The results suggest that both deteriorating expectations and revenue-raising tax changes weaken real GDP growth, although the responses are estimated with considerable uncertainty.

To compare the magnitude of these effects with existing estimates for interwar Britain, we construct the static cumulative tax multiplier used by Cloyne et al. (2024). This measures the cumulative change in the level of GDP relative to the cumulative tax change, under the assumption that the initial tax change persists. For the first h years following a tax action, the multiplier is

$$M_h^S = \frac{\sum_{j=0}^{h-1} \Delta Y_{t+j}}{h \Delta T_t}, \tag{11}$$

where ΔY_{t+j} is the change in the level of GDP attributable to the tax action and ΔT_t is the initial tax change. For the alternative specifications, ΔT_t refers to the corresponding component of tax policy. The VAR is estimated in GDP growth, so we obtain the corresponding GDP-level effects by cumulating the estimated growth responses. Since our tax-policy measures are normalised by previous-year revenue rather than GDP, we scale the multipliers using the average revenue-to-GDP ratio over the sample, which is 17.9 per cent.

Table 4 reports the multiplier for our baseline measure of tax policy, together with separate

[11] A potential concern is that there is an expected shock that affects both policy changes and realised GDP growth. However, this is mitigated by including policymaker expectations.

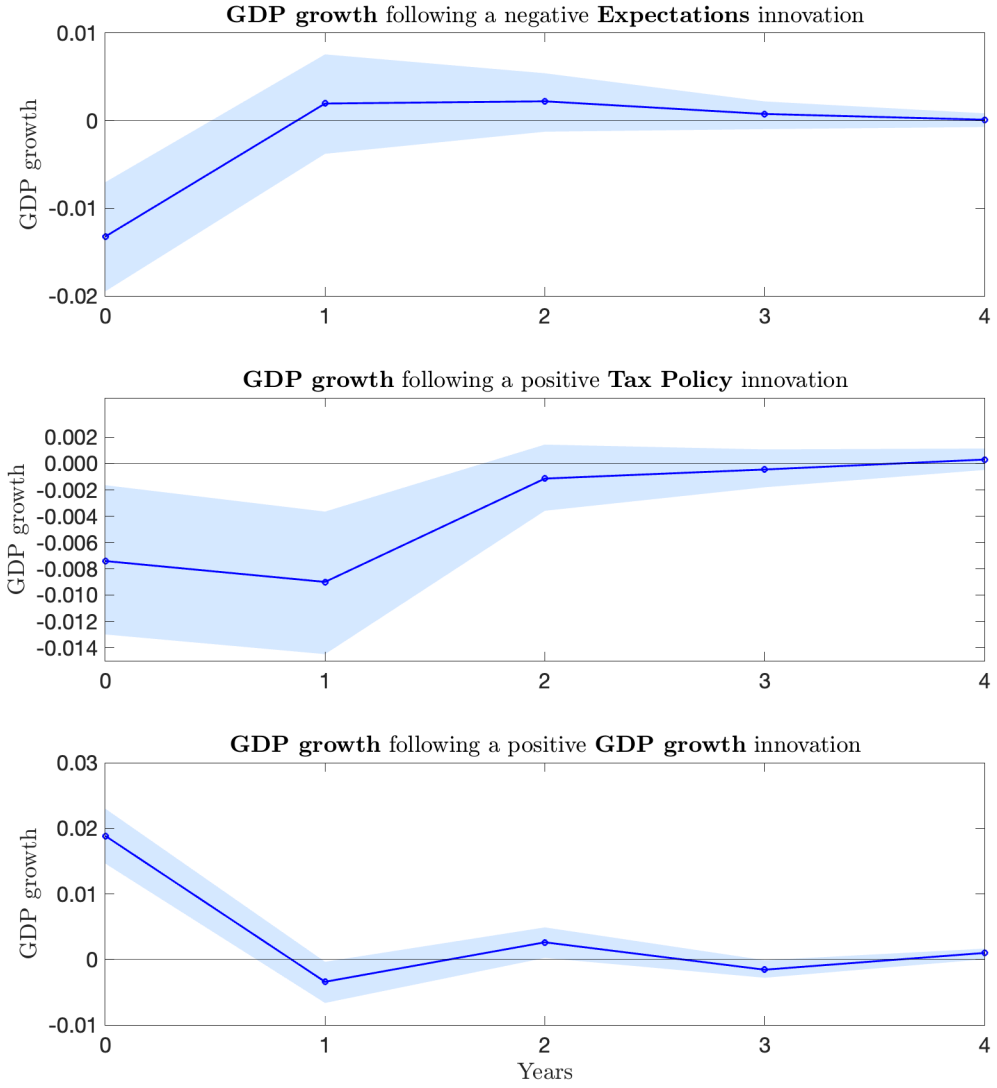


Figure 12: Responses of GDP growth to innovations, 25th to 75th percentiles

Years after	Our estimates			Cloyne et al. (2024)
tax action	Tax + timing	Tax liability	Tax timing	Static multiplier
1	-2.13	-3.14	1.03	-1.78
	[-3.65,-0.49]	[-4.97,-1.24]	[-4.89,6.09]	
2	-3.46	-4.73	-0.66	-2.30
	[-5.05,-1.76]	[-6.59,-2.78]	[-7.13,5.23]	
3	-4.01	-5.38	-1.31	–
	[-5.78,-2.10]	[-7.35,-3.26]	[-8.26,5.16]	
4	-4.32	-5.67	-1.98	–
	[-6.15,-2.30]	[-7.71,-3.44]	[-9.28,5.03]	

Notes: The table reports static cumulative tax multipliers. "Tax + timing" includes changes in tax liabilities and the timing of tax payments. Brackets report the 25th and 75th percentiles of the bootstrap distribution. Cloyne et al. (2024) report corresponding static cumulative multipliers for up to eight quarters, with signs reversed to match our convention that positive tax changes raise forecast revenue.

Table 4: Static cumulative tax multipliers

estimates for changes in tax liabilities and changes in the timing of tax payments. The static cumulative multiplier is -2.13 over the first year following a tax change, compared with -1.78 in Cloyne et al. (2024), and rises in absolute magnitude to -3.46 after two years, compared with -2.30. The estimates point to an important distinction between different types of tax change. When we restrict the measure to changes in underlying tax liabilities, the multiplier is considerably larger, reaching -3.14 after one year and -4.73 after two. By contrast, changes in the timing of tax payments have imprecisely estimated effects on GDP. The point estimates are initially positive but turn negative at longer horizons, although the uncertainty around them is substantial. This difference in dynamics may reflect differences in persistence, since changes in tax liabilities are more likely to be permanent, whereas timing measures typically shift receipts between financial years without changing the underlying liability.

The sizeable tax multipliers estimated above raise the question of how GDP might have evolved had policymakers not revised taxes in response to changes in their expectations. To answer this question, we use the trivariate VAR to construct a counterfactual path in which tax policy is assumed not to respond to policymaker expectations. The innovations we identify in expectations allow us to recover the resulting tax-policy responses and trace their effects on the economy through the estimated VAR dynamics. We then shut these responses down in every period while holding all other structural innovations at their historical values. This isolates the effect of expectations operating through tax policy while preserving their direct effect on economic activity. Removing this effect from observed GDP growth and cumulating the resulting growth rates yields the counterfactual level of GDP.

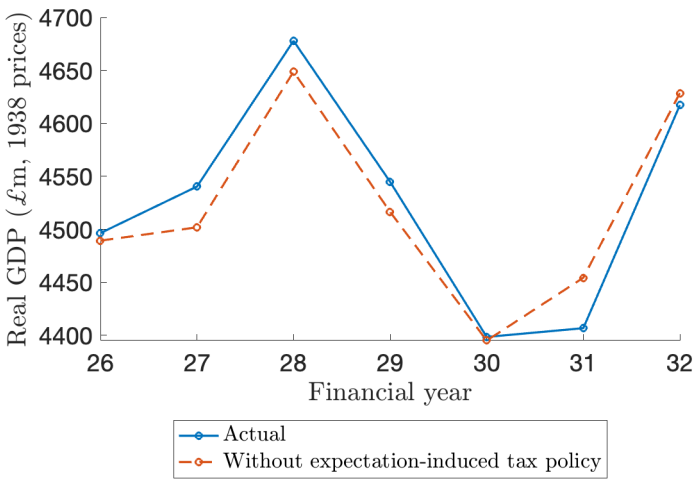


Figure 13: Actual and counterfactual GDP without expectation-induced tax policy

Figure 13 compares the counterfactual path with actual GDP. The point estimates suggest that the paths initially diverge following the improvement in policymaker expectations in 1927, which is associated with a revenue-reducing tax response. Without this response, the resulting stimulus would have been absent, leaving counterfactual GDP below actual GDP in the late 1920s. This pattern reverses as expectations deteriorate and the estimated tax response shifts towards raising revenue, particularly in 1930 and 1931. The contractionary effects propagate through the VAR dynamics, with the point estimate of counterfactual GDP overtaking actual GDP in 1931 and remaining higher in 1932. Thereafter, the two paths converge and remain close for most of the rest of the sample. These differences are imprecisely estimated, however, with the 25th and 75th percentiles of the bootstrap distribution for the difference between counterfactual and actual GDP spanning zero throughout the sample.

The counterfactual suggests that the historical procyclicality of discretionary tax policy may have delayed and weakened the recovery of the UK economy from the Great Depression. Our point estimates indicate that successive tax increases in the downturn had a contractionary effect on output and were largely driven by the deterioration in the Treasury's outlook. Economic activity would have recovered more rapidly had discretionary tax changes instead been acyclical and unresponsive to policymakers' economic expectations. The magnitude of these effects remains uncertain, reflecting imprecision in estimating the factor, the tax response and the macroeconomic impact.

11 Conclusion

Revenue forecasts provide us with the raw material for recovering otherwise unobserved policymaker expectations. In our application, archival evidence allows us to link common variation in the Treasury's revenue forecasts to changes in its economic outlook. We use this evidence to identify a Bayesian dynamic factor model and recover a measure of policymaker expectations that accords closely with contemporary assessments. The approach has potential beyond this setting. Administrative records often reflect beliefs that were never recorded directly, and archival evidence can provide the identifying information needed to recover them.

The expectations we recover trace how policymakers' beliefs evolved over the interwar period. They deteriorated around the return to gold and again during the Great Depression, before improving with the economic recovery. These movements are closely supported by the historical evidence, while the decomposition into real growth and inflation expectations provides further insight into how policymakers understood the major economic fluctuations of the period. Recovering these expectations also allows us to connect fiscal decisions to the beliefs on which they were based. Tax policy is estimated to have responded systematically, with deteriorating expectations prompting tax increases and improving expectations prompting tax cuts. This procyclical response was particularly pronounced during the Great Depression.

The procyclical tax-policy response appears to have affected economic activity. Tax increases are estimated to have reduced GDP growth, with sizeable multipliers, indicating that the policy responses we identify were economically meaningful. The counterfactual goes a step further, suggesting that the response to deteriorating expectations amplified the Great Depression and weakened the subsequent economic recovery. More broadly, expectations can affect economic outcomes not only directly, but through the policy decisions they induce.

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A Additional Results for the Baseline Model

We assess the sensitivity of the baseline estimates to the informativeness of the priors by re-estimating the model after doubling their standard deviations while leaving the prior means unchanged. Tables A.1 and A.2 report the resulting prior and posterior distributions. Loosening the priors allows the posterior elasticities to move further from the values implied by the Treasury matching exercise, providing a check on the extent to which the estimated expectations factor depends on that prior information.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\lambda_{1,1}$	Normal	0.27	0.2	0.41	[0.22,0.58]
$\lambda_{2,0}$	Normal	-0.48	0.4	-0.57	[-1.00,-0.18]
$\lambda_{2,1}$	Normal	0.42	0.4	0.22	[-0.08,0.49]
$\lambda_{3,0}$	Normal	0.48	0.4	-0.21	[-0.72,0.31]
$\lambda_{3,1}$	Normal	-0.42	0.4	-0.36	[-0.77,0.06]
$\lambda_{4,0}$	Normal	0.82	0.4	1.06	[0.41,1.77]
$\lambda_{4,1}$	Normal	-0.48	0.4	-0.55	[-1.14,0.03]
$\lambda_{5,0}$	Normal	0.00	0.4	0.53	[0.29,0.81]
$\lambda_{6,0}$	Normal	0.33	0.2	0.07	[-0.06,0.18]
$\lambda_{7,0}$	Normal	0.33	0.2	-0.02	[-0.11,0.07]
$\lambda_{8,0}$	Normal	0.00	0.4	-0.07	[-0.18,0.05]
$\lambda_{9,0}$	Normal	0.00	0.4	-0.00	[-0.06,0.06]
$\lambda_{10,0}$	Normal	0.00	0.4	0.06	[-0.05,0.17]

Table A.1: Prior and posterior distributions of elasticities with looser priors

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\Psi(0)$	Normal	0.0	1.0	-0.15	[-0.72,0.38]
σ_η	Inverse Gamma	0.5	2.0	0.18	[0.11,0.24]
$\sigma_{e,1}$	Inverse Gamma	0.1	0.2	0.04	[0.03,0.05]
$\sigma_{e,2}$	Inverse Gamma	0.1	0.4	0.05	[0.04,0.07]
$\sigma_{e,3}$	Inverse Gamma	0.1	0.4	0.07	[0.05,0.10]
$\sigma_{e,4}$	Inverse Gamma	0.3	0.4	0.24	[0.16,0.31]
$\sigma_{e,5}$	Inverse Gamma	0.1	1.0	0.06	[0.03,0.09]
$\sigma_{e,6}$	Inverse Gamma	0.1	0.2	0.03	[0.02,0.04]
$\sigma_{e,7}$	Inverse Gamma	0.1	0.2	0.04	[0.03,0.05]
$\sigma_{e,8}$	Inverse Gamma	0.1	1.0	0.04	[0.03,0.05]
$\sigma_{e,9}$	Inverse Gamma	0.1	1.0	0.02	[0.02,0.03]
$\sigma_{e,10}$	Inverse Gamma	0.1	1.0	0.03	[0.02,0.04]

Table A.2: Prior and posterior distributions of other parameters with looser priors

Despite weaker priors and some changes in the posterior parameter estimates, the main historical movements in the common factor are preserved. Figure A.1 shows the estimated factor under the looser priors. As in the baseline specification, expectations deteriorate sharply in 1925 and during the Great Depression, before recovering from 1934. The magnitude of some movements changes, but the broad historical pattern is similar to the baseline estimate in Figure 5.

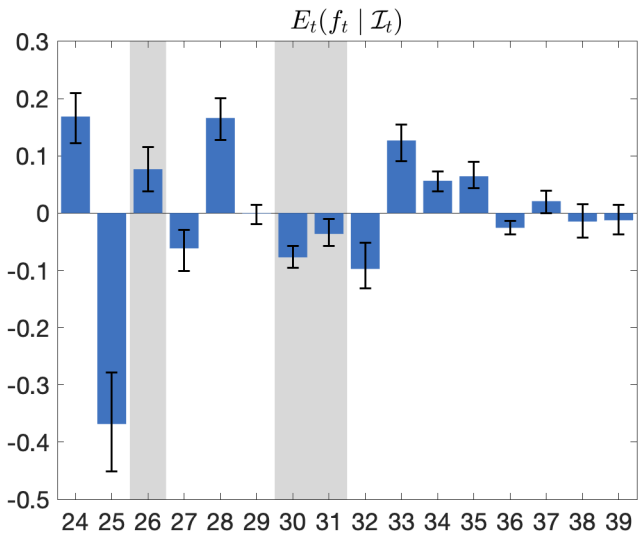


Figure A.1: Estimate of the common factor in the Bayesian state-space model with looser priors

Figure A.2 presents the historical shock decomposition of Income Tax revenue forecasts. Because Income Tax depends on average economic activity over the previous three years, the contribution of the common factor differs substantially from the path of the factor itself.

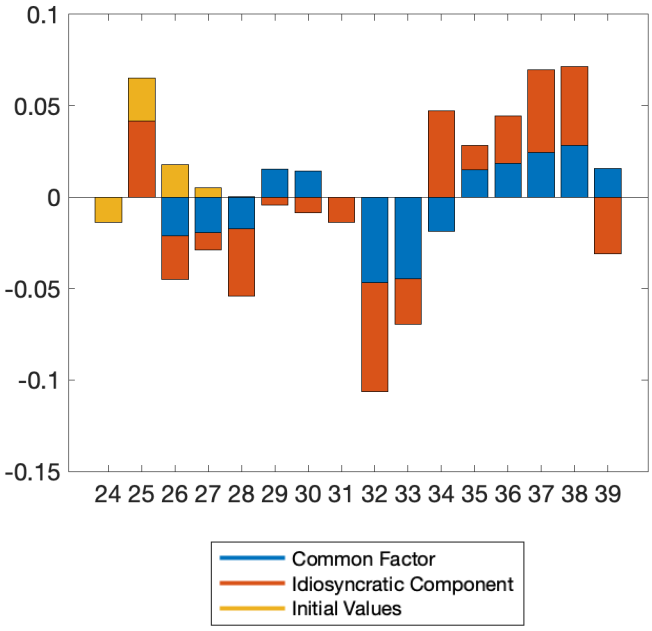


Figure A.2: Historical shock decomposition of Income Tax revenue forecasts

B Inflation versus Real Growth Decomposition

The specification of the two-factor model closely mirrors that of the single-factor model. The main difference is that items 7–9 (Excise, Motor Vehicle Duties, and the Post Office) depend only on the real growth factor. We denote the corresponding elasticities by $\lambda_{7,0}^{\Delta y}$, $\lambda_{8,0}^{\Delta y}$, and $\lambda_{9,0}^{\Delta y}$ to distinguish them from the previous specification. Elasticities without the Δy superscript refer, as before, to the response of revenue forecasts to changes in nominal activity.

The priors for the elasticities in the two-factor model are reported in Table B.1. The only change relative to the single-factor model is an increase in the prior mean for $\lambda_{7,0}^{\Delta y}$, the elasticity of Excise revenue forecasts with respect to the real growth factor. This adjustment is motivated by the forecast-matching exercise, where the estimate of 0.33 measures the response of Excise revenue forecasts to changes in policymakers' expectations of nominal activity. Since prices and real output move by approximately equal proportions in the matching exercise, the implied elasticity with respect to real growth alone is twice as large, giving a prior mean of 0.66.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\lambda_{1,1}$	Normal	0.27	0.1	0.31	[0.19,0.48]
$\lambda_{2,0}$	Normal	-0.48	0.2	-0.52	[-0.82,-0.31]
$\lambda_{2,1}$	Normal	0.42	0.2	0.27	[-0.00,0.49]
$\lambda_{3,0}$	Normal	0.48	0.2	0.15	[-0.15,0.47]
$\lambda_{3,1}$	Normal	-0.42	0.2	-0.53	[-0.82,-0.24]
$\lambda_{4,0}$	Normal	0.82	0.2	0.85	[0.50,1.18]
$\lambda_{4,1}$	Normal	-0.48	0.2	-0.47	[-0.79,-0.15]
$\lambda_{5,0}$	Normal	0.00	0.2	0.24	[-0.01,0.53]
$\lambda_{6,0}$	Normal	0.33	0.1	0.15	[0.05,0.27]
$\lambda_{7,0}^{\Delta y}$	Normal	0.66	0.1	0.57	[0.42,0.74]
$\lambda_{8,0}^{\Delta y}$	Normal	0.00	0.2	-0.01	[-0.26,0.23]
$\lambda_{9,0}^{\Delta y}$	Normal	0.00	0.2	0.04	[-0.13,0.20]
$\lambda_{10,0}$	Normal	0.00	0.2	0.03	[-0.06,0.12]

Table B.1: Prior and posterior distributions of elasticities in the two-factor specification

Priors for the remaining parameters are reported in Table B.2. Aside from the changes required by the move to a two-factor specification, they are unchanged from the single-factor model. Specifically, the AR(1) coefficients for the real growth and inflation factors, $\Psi(0)^{\Delta y}$ and $\Psi(0)^{\pi}$, each have a prior mean of zero, while the innovation standard deviations of the two factors are each reduced by a factor of two. Reducing the standard deviations in this way preserves the broad balance in the priors between common factors and idiosyncratic components as sources of variation in revenue forecasts under the two-factor specification.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\Psi(0)^{\Delta y}$	Normal	0.0	0.5	0.02	[-0.57,0.61]
$\Psi(0)^{\pi}$	Normal	0.0	0.5	-0.02	[-0.59,0.58]
$\sigma_{\eta}^{\Delta y}$	Inverse Gamma	0.25	1.0	0.08	[0.05,0.10]
σ_{η}^{π}	Inverse Gamma	0.25	1.0	0.15	[0.07,0.22]
$\sigma_{e,1}$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,2}$	Inverse Gamma	0.1	0.2	0.05	[0.04,0.07]
$\sigma_{e,3}$	Inverse Gamma	0.1	0.2	0.08	[0.05,0.11]
$\sigma_{e,4}$	Inverse Gamma	0.3	0.2	0.26	[0.19,0.34]
$\sigma_{e,5}$	Inverse Gamma	0.1	0.5	0.08	[0.04,0.12]
$\sigma_{e,6}$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,7}$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.06]
$\sigma_{e,8}$	Inverse Gamma	0.1	0.5	0.04	[0.03,0.05]
$\sigma_{e,9}$	Inverse Gamma	0.1	0.5	0.02	[0.02,0.03]
$\sigma_{e,10}$	Inverse Gamma	0.1	0.5	0.03	[0.02,0.04]

Table B.2: Prior and posterior distributions of other parameters in the two-factor specification

The prior and posterior parameter distributions for the two-factor estimation are in Figure B.1.

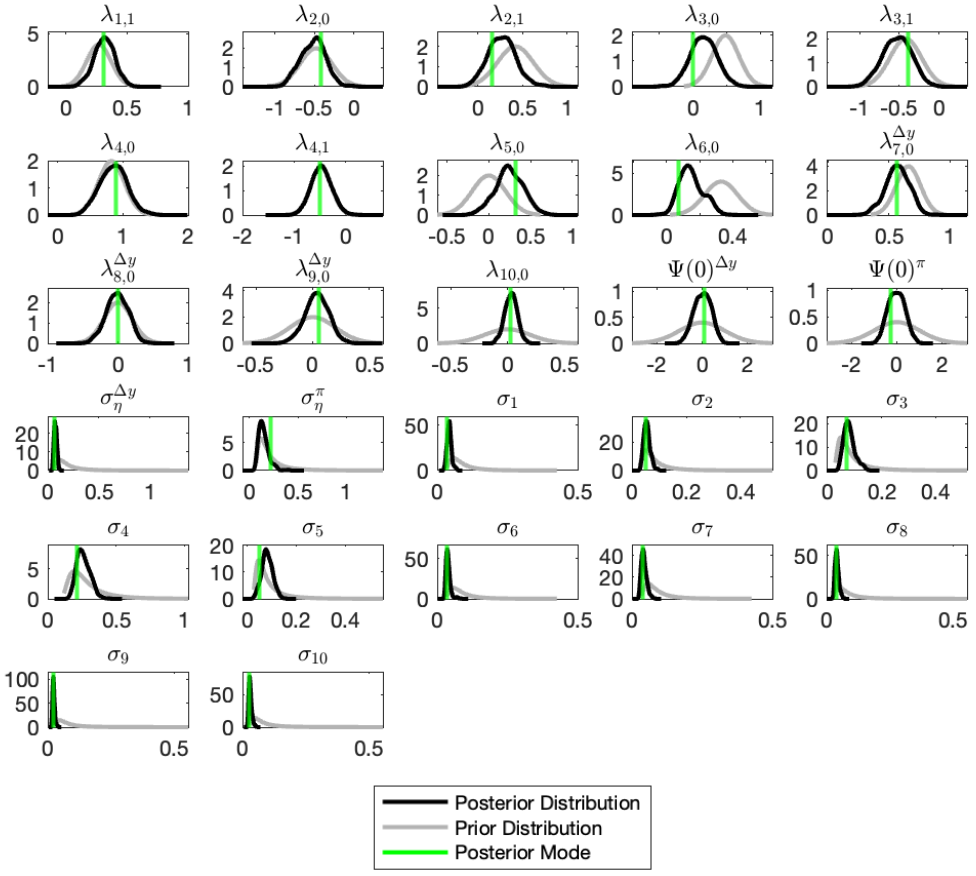


Figure B.1: Prior and Posterior Parameter Distributions in the Two-Factor Specification

C The Emergency Budget of September 1931

This appendix reports the prior and posterior distributions for the extended model incorporating the September 1931 revenue forecasts described in Section 8. Table C.1 reports the elasticity parameters, while Table C.2 reports the remaining parameters.

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
$\lambda_{1,1}$	Normal	0.27	0.1	0.26	[0.15,0.36]
$\lambda_{2,0}$	Normal	-0.48	0.2	-0.46	[-0.67,-0.25]
$\lambda_{2,1}$	Normal	0.42	0.2	0.24	[0.02,0.44]
$\lambda_{3,0}$	Normal	0.48	0.2	-0.07	[-0.31,0.18]
$\lambda_{3,1}$	Normal	-0.42	0.2	-0.43	[-0.71,-0.15]
$\lambda_{4,0}$	Normal	0.82	0.2	0.92	[0.64,1.24]
$\lambda_{4,1}$	Normal	-0.48	0.2	-0.51	[-0.81,-0.22]
$\lambda_{5,0}$	Normal	0.00	0.2	0.21	[0.07,0.36]
$\lambda_{6,0}$	Normal	0.33	0.1	0.19	[0.07,0.33]
$\lambda_{7,0}$	Normal	0.33	0.1	0.20	[0.06,0.33]
$\lambda_{8,0}$	Normal	0.00	0.2	0.03	[-0.14,0.22]
$\lambda_{9,0}$	Normal	0.00	0.2	0.02	[-0.07,0.13]
$\lambda_{10,0}$	Normal	0.00	0.2	0.06	[-0.07,0.19]

Table C.1: Prior and posterior distributions of elasticities with September 1931 budget

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	St. Dev.	Mean	90% Credible Interval
Ψ^A	Normal	0.04	0.1	0.02	[-0.13,0.14]
Ψ^S	Normal	1.0	0.5	1.01	[0.32,1.76]
σ_η^A	Inverse Gamma	0.5	1.0	0.28	[0.15,0.43]
σ_η^S	Inverse Gamma	0.5	1.0	0.15	[0.10,0.21]
$\sigma_{e,1}^A$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,2}^A$	Inverse Gamma	0.1	0.2	0.05	[0.03,0.06]
$\sigma_{e,3}^A$	Inverse Gamma	0.1	0.2	0.07	[0.04,0.10]
$\sigma_{e,4}^A$	Inverse Gamma	0.3	0.2	0.23	[0.17,0.30]
$\sigma_{e,5}^A$	Inverse Gamma	0.1	0.5	0.08	[0.04,0.11]
$\sigma_{e,6}^A$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,7}^A$	Inverse Gamma	0.1	0.1	0.04	[0.03,0.05]
$\sigma_{e,8}^A$	Inverse Gamma	0.1	0.5	0.05	[0.03,0.06]
$\sigma_{e,9}^A$	Inverse Gamma	0.1	0.5	0.02	[0.02,0.03]
$\sigma_{e,10}^A$	Inverse Gamma	0.1	0.5	0.03	[0.02,0.04]
$\sigma_{e,1}^S$	Inverse Gamma	0.1	0.1	0.11	[0.03,0.22]
$\sigma_{e,2}^S$	Inverse Gamma	0.1	0.2	0.07	[0.03,0.11]
$\sigma_{e,3}^S$	Inverse Gamma	0.1	0.2	0.08	[0.03,0.14]
$\sigma_{e,4}^S$	Inverse Gamma	0.3	0.2	0.30	[0.10,0.61]
$\sigma_{e,5}^S$	Inverse Gamma	0.1	0.5	0.06	[0.03,0.09]
$\sigma_{e,6}^S$	Inverse Gamma	0.1	0.1	0.09	[0.04,0.16]
$\sigma_{e,7}^S$	Inverse Gamma	0.1	0.1	0.08	[0.03,0.16]
$\sigma_{e,8}^S$	Inverse Gamma	0.1	0.5	0.05	[0.02,0.09]
$\sigma_{e,9}^S$	Inverse Gamma	0.1	0.5	0.07	[0.03,0.11]
$\sigma_{e,10}^S$	Inverse Gamma	0.1	0.5	0.07	[0.02,0.13]

Table C.2: Prior and posterior distributions of other parameters with September 1931 budget

Figure C.1 compares the prior and posterior distributions of these parameters.

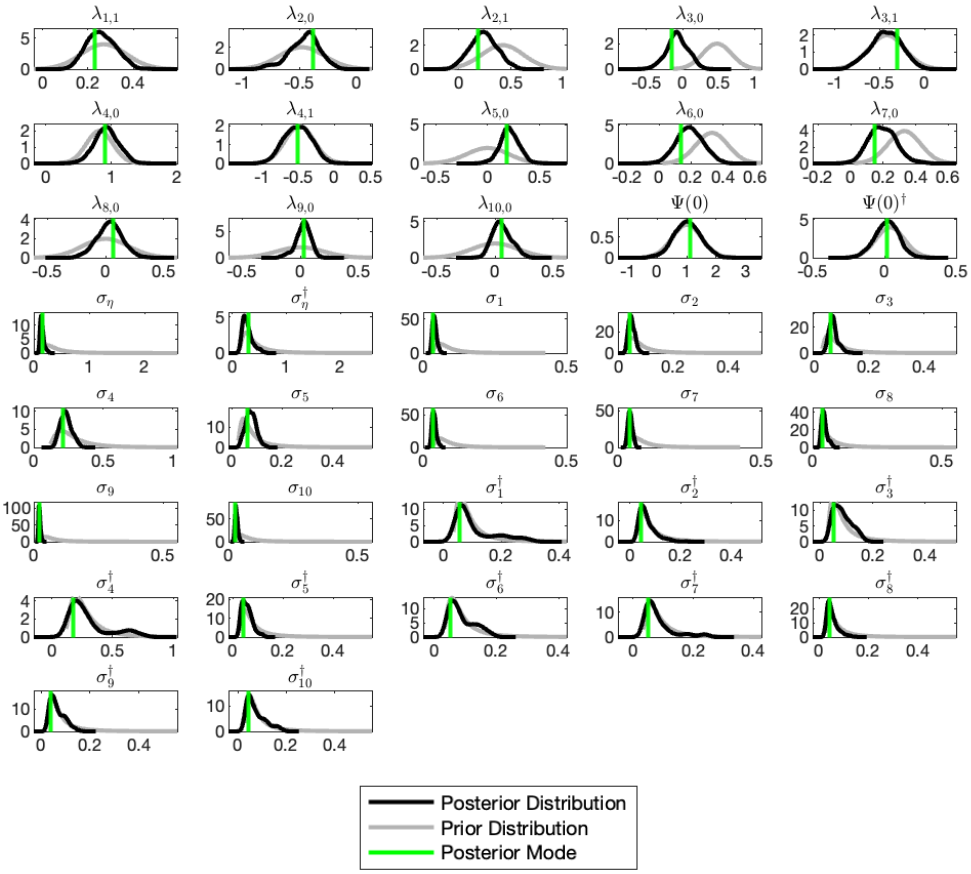


Figure C.1: Prior and posterior parameter distributions with September 1931 budget