The Effects of Transitory, Permanent, and Anticipated U.S. Import Tariff Shocks*

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First draft July 3, 2025
This draft June 7, 2026

Abstract

We estimate the effects of U.S. import tariff shocks. We find that distinguishing between transitory, permanent and anticipated tariff shocks is important. Transitory tariff increases lower inflation, increase output, and weaken absorption. Permanent tariff increases trigger a one-off increase in the price level but are not contractionary. Anticipated tariff increases are inflationary and contractionary. Consistent with the intertemporal approach, transitory tariff increases improve the trade balance, anticipated ones deteriorate it, and permanent ones leave it largely unchanged. Tariff shocks are estimated to be minor drivers of U.S. business cycles. The estimated effects are shown to be qualitatively consistent with the predictions of an optimizing model with an import-competing sector.

JEL classification: F41, E52, E31, F13.
Keywords: Import tariff shocks, inflation, output, trade balance, real exchange rate, monetary policy, Nixon shock, Trump shock.

*We thank Louphou Coulibaly, Adrien Auclert, Daniel Ostry, and Lukas Boer for a discussion and seminar participants at the Federal Reserve Banks of Philadelphia, Richmond, and San Francisco, Columbia, IMF, Luxembourg, MIT, LSE, 2026 Konstanz Seminar, UDLA (Quito), 2026 T2M (Montreal), the 2025 GCAP conference, the NBER IFM Fall 2025 meeting, the IMIM online seminar, the Turin "Policy Challenges in a Changing Global Economy" conference, and the 12th Atlanta Workshop on International Economics for comments. Patricio Goldstein and Jack Johnson provided excellent research assistance. An earlier draft of this paper appeared as NBER working paper 33997, July 2025, under the title "Transitory and Permanent Import Tariff Shocks in the United States: An Empirical Investigation."

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1 Introduction

This paper empirically investigates the macroeconomic effects of import tariff shocks. It addresses a number of questions that have been in the minds of observers both in academic and policy circles for a long time and have resurfaced with vigor since the Trump administration's imposition of a broad array of import tariffs: Are tariff increases inflationary? Are they contractionary? Are they effective in improving the external accounts? How has the Fed dealt with them?

We begin with the observation that, in dynamic optimizing macroeconomic models, the effects of import tariff shocks depend on their persistence. For example, in a framework where tariffs affect the intertemporal relative price of consumption, transitory tariff increases reduce current demand and improve the external accounts. In contrast, permanent tariff increases, because they do not alter the relative price of consumption across periods, have less of an effect on the external accounts. Motivated by this observation, we estimate the impact of tariffs using an empirical model cast in latent-state-space form that explicitly distinguishes between transitory and permanent tariff shocks.

The model aims to explain the behavior of import tariffs, inflation, output, the nominal interest rate, imports, the trade balance, domestic absorption, and the real exchange rate. It is driven by a number of transitory and permanent shocks, including transitory, permanent, and anticipated tariff shocks. We estimate the model using U.S. quarterly data from 1959:Q1 to 2024:Q4. The use of quarterly data is important because transitory tariff events can come and go within a single year. The focus on the post 1950s period has three advantages. First, quarterly macroeconomic data are available on a consistent basis. Second, the federal revenue structure had by then acquired its modern form: the individual income tax had become the dominant source of federal revenue, while customs duties had ceased to play a major fiscal role. Third, after the 1951 Treasury–Federal Reserve Accord, the conduct of monetary policy was no longer subordinated to Treasury debt management and had begun to resemble the modern regime of an independent central bank. Beginning the sample in 1959 therefore helps avoid confounding the effects of tariff shocks with major changes in U.S. fiscal and monetary-policy structures.

We proxy the import tariff rate using three alternative measures, the trade-weighted import tariff rate, the trade restrictiveness index (TRI), and a fixed-weight import tariff rate. Neither the TRI nor the fixed-weight tariff measures were available at a quarterly frequency prior to the present study. An empirical contribution of this paper is to fill this gap and to make these new time series publicly available.[1]

[1] See https://www.columbia.edu/~mu2166/import_tariff/.

We estimate the empirical model using Bayesian techniques. The focus of our analysis is on the macroeconomic effects of identified transitory and permanent movements in import tariffs. We find that transitory increases in tariffs are not inflationary; in fact, inflation falls in response to such shocks. This result runs counter to the conventional view that higher tariffs are passed through to prices and therefore raise inflation. However, a tariff increase represents a relative price change, whereas inflation is a generalized rise in nominal prices. Whether a relative price change translates into inflation depends on a host of factors, including the tariff shock's persistence, the behavior of markups and aggregate demand, and the stance of monetary policy. We find that a temporary tariff increase depresses domestic consumption, suggesting that the resulting decline in inflation could be demand driven. Such a fall in aggregate demand can lower inflation even if the Fed eases monetary policy, provided the easing is not strong enough to offset the demand contraction.

We also find that transitory tariff increases do not reduce output and do not trigger a tightening of monetary policy. In fact, the Fed eases money market conditions, which is in line with the hypothesis that transitory tariff increases lower aggregate demand.

Permanent tariff shocks have markedly different effects that conform more closely to the conventional view. They are estimated to cause a one-time, permanent increase in the price level (effectively a brief rise in inflation) without depressing output. In response, the Federal Reserve tightens policy on impact, but quickly reverts to a neutral stance.

The responses of the external accounts to tariff shocks are consistent with the predictions of the intertemporal approach to the current account: we find that in response to a transitory increase in tariffs the trade balance improves, whereas in response to a permanent increase it is little changed. We also examine whether tariff shocks influence U.S. competitiveness by estimating their effects on the real exchange rate. We find that both transitory and permanent tariff increases have statistically insignificant effects on the real exchange rate, implying that tariff hikes neither appreciate nor depreciate the dollar in real terms. Beyond their theoretical interest, these results are of policy relevance, as the questions of whether tariffs are an effective tool for reducing trade imbalances or making the United States more internationally competitive are almost always at the center of discussions around episodes of tariff hikes.

We also assess the role of import tariff shocks as drivers of U.S. business cycles. We find that they do not play an important role. Variance decomposition analysis indicates that, taken together, transitory and permanent movements in import tariffs account for only about 5 percent of the variation in inflation, output, and the interest rate. This limited influence holds not only on average, but also during prominent episodes of tariff increases, such as those implemented by Presidents Nixon in 1971, Ford in 1975, and Trump in 2018, regardless of whether these episodes are estimated to have been transitory or permanent in nature. Specifically, we estimate that the Nixon and Ford tariff increases were primarily transitory, while the Trump tariffs had a more permanent component, yet we find that in all cases their macroeconomic effects were modest.

A common view is that tariff changes are often anticipated through policy announcements. To address this concern, we take advantage of the fact that our latent state-space model allows for the joint estimation of transitory and permanent shocks with anticipated and unanticipated components. We find that the data favor the specification without anticipation. Conditional on including anticipated shocks, we find that the estimated responses to unanticipated tariff shocks remain virtually unchanged. Interestingly, transitory anticipated tariff shocks, unlike their unanticipated counterparts, are estimated to be inflationary and contractionary. This result highlights the need to distinguish not only transitory from permanent tariff shocks, but also anticipated from unanticipated ones.

To shed light on the economic plausibility of the estimated effects of tariff shocks, we show that they are consistent with the predictions of an optimizing open economy model. Specifically, we add an import-competing sector to Calvo's (1987) model of transitory and permanent tariff shocks. In the resulting model, a transitory increase in import tariffs raises the price of current consumption in terms of future consumption, inducing a fall in current domestic absorption and an improvement in the trade balance. The protection provided by the tariff stimulates production in the import-competing sector causing an increase in domestic output despite the decline in domestic absorption. These results are qualitatively in line with the corresponding estimated effects. Further, we show that if the monetary authority looks through the temporary tariff increase by leaving interest rates unchanged, the tariff increase is not passed through to prices. In this way the model can capture the empirical finding that transitory tariff shocks are not inflationary and are not associated with monetary tightening. By contrast, a permanent increase in the import tariff does not affect the intertemporal relative price of consumption and therefore leaves domestic absorption, output, and the trade balance unchanged. These results are also in line with our empirical findings.

Related Literature. This paper is related to a literature on the effects of import tariffs that has grown significantly over the past years. One branch of the literature, including the present paper, aims to estimate the macroeconomic effects of tariff shocks. Boer and Rieth (2024), using U.S. quarterly data, follow an SVAR approach to estimate the macroeconomic effects of tariff shocks using sign and narrative identification restrictions. To our knowledge, these authors are the first to empirically estimate the macroeconomic effects of U.S. tariffs using a dynamic approach. The main departure of the present paper from their work is twofold: first, their work assumes, as a way to identify tariff shocks, that they must cause an increase in the price level, ruling out by assumption the possibility that tariff increases may fail to be inflationary, which is one of the main results of our investigation. Second, their framework does not distinguish between transitory and permanent movements in tariffs. This distinction is important because, as explained above, our estimation indicates that these two type of shocks have different macroeconomic effects.

Barattieri, Cacciatore, and Ghironi (2021) examine the dynamic macroeconomic effects of temporary trade barriers using Canadian data, specifically, the initiation of antidumping investigations, and find that these measures are inflationary and contractionary, which is the opposite of our results. However, we interpret initiations of antidumping investigations as capturing anticipated tariff increases and thus different from our temporary tariff shock, which is unanticipated. As mentioned above, when we expand our model to include anticipation in trade policy, we find that transitory anticipated tariff increases are indeed inflationary and contractionary. Amiti et al. (2024) study the response of financial variables, including nominal and real interest rates, to the Trump 2018 tariff announcements and find that these had a significant negative effect on expected inflation.

There is a literature devoted to measuring the economic effects of tariffs using microeconomic data. See, for example, Amiti, Redding, and Weinstein (2019), Fajgelbaum et al. (2020), Flaaen, Hortacsu, and Tintelnot (2020), and Cavallo et al. (2021), and the literature review by Fajgelbaum and Khandelwal (2022). This body of work has provided valuable insights on the price and welfare effects of tariff changes using granular information. A central result that emerges from this micro approach is that import tariff increases have a near one-to-one pass-through to import prices, and that their effect on income is negative albeit small. A methodological difference between this literature and the present study is that the former is static. This distinction is important because an intertemporal approach allows one to separate transitory and permanent changes in tariff, which, as empirically documented here, can give rise to different effects on inflation, output, and the external accounts.

Early theoretical contributions that are related to our empirical framework are Razin and Svensson (1983) and Calvo (1987). These papers study the effects of tariffs in an optimizing model that distinguishes between permanent and transitory tariff shocks. They show that transitory (or noncredible) changes in tariffs cause a fall in aggregate demand and an improvement in the trade balance, while permanent (or credible) changes can leave both variables unchanged. These results are broadly consistent with our empirical findings. We extend this framework to incorporate an import-competing sector and show that this modification is key to replicate our empirical finding that a transitory tariff increase causes at the same time an expansion in output and a contraction in domestic absorption.

More recently, each of the two Trump tariff shocks has triggered a wave of theoretical work analyzing the macroeconomic effects of tariffs, including contributions by Barattieri, Cacciatore, and Ghironi (2021), Auray, Devereux, and Eyquem (2022, 2024), Bergin and Corsetti (2023), Erceg, Prestipino, and Raffo (2023), Boer and Rieth (2024), Jeanne and Son (2024), Kalemli-Özcan, Soylu, and Yıldırım (2025), Monacelli (2025), Bianchi and Coulibaly (2025), Cuba-Borda et al. (2025), Auclert, Rognlie, and Straub (2025), Itskhoki and Mukhin (2025), Costinot and Werning (2025), Werning, Lorenzoni, and Guerrieri (2025), and Ambrosina, Chan, and Tenreyro (2026). A characteristic of this recent literature, which distinguishes it from earlier contributions, is a stronger emphasis on quantitative and normative implications.

Finally, the econometric approach follows Uribe (2022).

The remainder of the paper is organized as follows. Section 2 describes the construction of our three import tariff measures. Section 3 develops the empirical model and describes the identification strategy, the data, and the estimation procedure. Section 4 presents the estimated effects of transitory and permanent tariff shocks. Section 5 presents a theoretical model of an open economy with an import-competing sector to interpret the main empirical findings. Section 6 introduces anticipated tariff shocks and performs a number of robustness checks. Section 7 offers concluding remarks.

2 Measuring the U.S. Import Tariff Rate

In reality, import tariffs vary across goods. One must therefore decide how to summarize these multiple tariff rates into a single index. Here, we construct quarterly time series for three alternative import tariff measures. The first one is the trade-weighted import tariff rate. The advantages of this measure are that it is relatively easy to construct and that data is available for a relatively long time span, since 1959:Q1. Its main disadvantage, in principle, is that it may suffer from composition bias. The second measure is a fixed-weight import tariff rate. The main advantage of this measure is that it controls for composition bias. Its main disadvantage is that it requires micro data on imports and duties at a quarterly frequency, which limits the beginning of the sample period to 1990:Q1. The third import tariff measure is the trade restrictiveness index (TRI). The main advantage of this tariff measure is that it is welfare based. Its main disadvantages are that it requires not only micro data on imports and duties, but also information on good-specific import demand elasticities. This time series also starts in 1990:Q1. To the best of our knowledge, quarterly time series for the latter two tariff measures were not available prior to the first draft of this paper, so we regard their construction as a contribution in itself. We have made both publicly available, along with the trade-weighted series (see footnote 1).

The main result of this section is that the three measures exhibit similar time-series properties. This finding suggests that the simple trade-weighted import tariff rate is not significantly affected by composition or substitution bias and provides a good summary of the actual tariff schedule. Thus, the evidence presented here justifies using the trade-weighted measure in the econometric analysis to take advantage of its long span. Section 6.4 shows that the results of the paper are robust to adding as observables the fixed-weighed and trade restrictiveness tariff measures.

2.1 The Trade-Weighted Import Tariff Rate

The trade-weighted import tariff rate, denoted τ_t, is defined as the ratio of U.S. import customs duties to the value of goods imports. Specifically, letting d_t denote import duties in period t and m_t the value of goods imports excluding duties in period t, we have that

$$\tau_t = \frac{d_t}{m_t}.$$

Data for d_t and m_t are available at a quarterly frequency since 1959:Q1. Appendix A provides data sources for d_t and m_t.

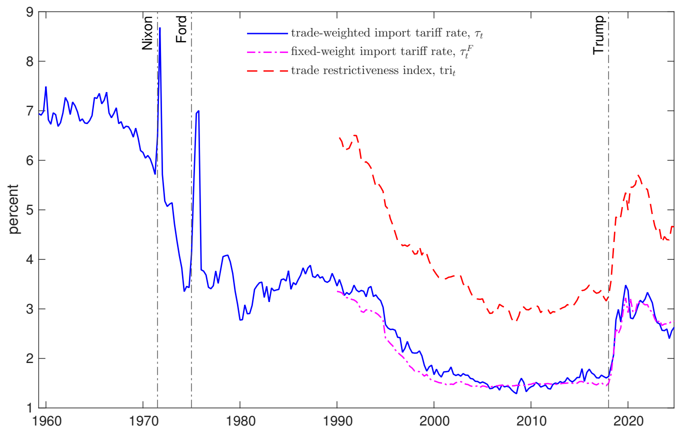
To see that this measure represents an import-weighted tariff rate, let d_{it} denote import duties on good i, m_{it} the value of imports of good i excluding duties, $\tau_{it} \equiv d_{it}/m_{it}$ the tariff rate on imports of good i, and $s_{it} \equiv m_{it}/m_t$ the import share of good i. Then, we can write the trade-weighted import tariff rate as

$$\tau_t = \sum_i s_{it}\tau_{it}. \tag{1}$$

Figure 1 displays the U.S. trade-weighted import tariff rate with a solid line. Overall, tariffs have trended downward over the past six decades: between 1959 and 2000, they fell from about 7 percent to around 2 percent. The trade-weighted tariff measure clearly captures the three major tariff episodes in the United States in our sample: The Nixon shock of 1971:Q3, when President Nixon imposed a 10 percent surcharge on all imported goods; the Ford shock of 1975:Q1, when President Ford introduced a \$2-per-barrel tax on oil imports, at a time when the market price of oil was approximately \$11 per barrel; and the Trump shock of 2018:Q1, when President Trump levied tariffs on approximately 15 percent of imported goods, primarily from China. But the figure also indicates that tariff rates exhibited considerable fluctuations outside of these three major episodes.

As stated above, the trade-weighted import tariff measure, τ_t, may be prone to composition bias. The reason is that when τ_{it} increases, s_{it} may endogenously fall, as consumers

Figure 1: U.S. Trade-Weighted Import Tariff Rate, Fixed-Weight Import Tariff Rate, and Trade Restrictiveness Index



Notes. Vertical lines mark the start of the three main import tariff episodes in the sample: Nixon 1971:Q3, Ford 1975:Q1, and Trump 2018:Q1. The series are seasonally adjusted and available at the URL given in footnote 1. Source: authors' calculations.

and firms substitute away from good i, causing an attenuation of the tariff increase (see equation (1)). To gauge whether this concern is quantitatively relevant, we construct two alternative import tariff measures that control for this source of bias.

2.2 Fixed-Weight Import Tariff Rate

As a second measure of an aggregate import tariff rate, we consider a fixed-weight measure that uses constant trade shares over time. Specifically, letting τ_t^F denote the fixed-weight import tariff rate, we define

$$\tau_t^F = \sum_i s_i \tau_{it}, \tag{2}$$

where s_i is a time-invariant good-specific trade weight for good i. The rationale for using time-invariant trade weights is to avoid mismeasuring movements in tariffs that arise from changes in the composition of imports, i.e., changes in s_{it}. These changes in the composition of imports may be driven by changes in good-specific tariffs or other type of disturbances, such as taste shocks.

Unlike the trade-weighted tariff measure, the fixed-weight measure requires information about good-specific imports, m_{it}, and duties, d_{it}. We use quarterly data at the harmonized tariff schedule (HTS) 6-digit product level for m_{it} and d_{it}. The data come from the United States International Trade Commission (USITC, 2025). To maintain a consistent definition of each good i throughout the sample, we map all HTS codes to a time-invariant classification using concordances from the United Nations (2025). Concordances across HTS product codes over time are needed because product definitions change from time to time as codes are added, split, or redefined. The data cover the period 1990:Q1 to 2024:Q4. The starting date is dictated by data availability. Product code concordance across time restricts the cross-sectional dimension of the sample to 4,025 imported products for which data is available throughout the sample, ensuring a balanced panel. This sample covers at least 90 percent of total duties collected in each period and at least 85 percent of the total value of imported goods in each period. The fixed weights are constructed as follows: for each good, i, we set s_i equal to the average import share across all quarters in 2006. This date is about in the middle of the sample, features relatively low and stable tariff rates, and is inside the great moderation (before the global financial crisis and the Covid-19 pandemic).

Figure 1 displays τ_t^F with a dash-dotted line and shows that it moves closely with the trade-weighted tariff rate, τ_t. The correlation between τ_t^F and τ_t is 0.97. This suggests that concerns that the trade-weighted tariff measure may suffer from composition bias do not appear to be significant.

As mentioned earlier, a further concern with both the trade-weighted and fixed-weight tariff proxies is that neither is welfare based, and thus may lack a clear economic interpretation. This motivates considering a third tariff measure.

2.3 The Trade Restrictiveness Index

The third measure of the aggregate tariff rate we consider comes from the trade literature, which has sought to obtain a uniform tariff rate that is equivalent, under some metric, to the actual tariff schedule. Anderson and Neary (1994) developed the trade restrictiveness index (TRI) defined as the uniform tariff in a given period that delivers the same level of welfare as the actual tariff schedule. This measure, however, is model specific and difficult to compute. Feenstra (1995) developed a simplified version of the TRI, which can be computed with model-free information. Specifically, the simplified TRI requires knowledge of good-specific import tariff rates, import shares, and import demand elasticities. Formally, the simplified TRI in period t, denoted tri_t, is given by

$$\mathrm{tri}_t = \left(\frac{\sum_i s_{it} \epsilon_i \tau_{it}^2}{\sum_i s_{it} \epsilon_i} \right)^{\frac{1}{2}}, \tag{3}$$

where ϵ_i denotes the price elasticity of import demand of good i.

Existing contributions provide either cross-sectional estimates of the TRI for selected years (Kee, Nicita, and Olarreaga, 2008) or historical yearly time series ending before the

Nixon shock, based on a coarse definition of product categories (Irwin, 2010). We construct a quarterly series of the U.S. TRI using information on imports, import duties, and import demand elasticities at the HTS 6-digit level. The source of the data on imports and duties, m_{it} and d_{it}, is as described in section 2.2. Product-level import demand elasticities are taken from Kee, Nicita, and Olarreaga (2008). The availability of elasticity estimates limits the sample to 2,761 imported products, which together account for at least 80 percent of total duties collected and at least 70 percent of the total value of U.S. imports in each quarter.

Figure 1 displays with a dashed line our estimate of the trade restrictiveness index, tri_t. The trade restrictiveness index is consistently higher than both the trade-weighted and the fixed-weight import tariff rates. The average gap is about 2 percentage points. However, what matters for our analysis is that the two series move in tandem over time, with a correlation of 0.97. The finding that the TRI is similar to the trade-weighted tariff rate, apart from a level difference, confirms similar results reported in the cross-country study by Kee, Nicita, and Olarreaga (2008) and the historical U.S. annual study by Irwin (2010).

The results of this section indicate that concerns about the trade-weighted measure, namely, that it may suffer from composition bias or lack meaningful economic content, are not large enough to justify shortening the sample (i.e., dropping 1959:Q1-1989:Q4). For this reason, we proceed as follows. The baseline estimation uses the trade-weighted index, τ_t. In section 6.4, we augment the set of observables with the fixed-weight tariff rate, τ_t^F, and with the TRI, tri_t (treating 1959:Q1-1989:Q4 as missing data for these series), and show that the main results of the paper are robust to the inclusion of this additional information.

3 Model, Identification, and Estimation

This section presents a model with transitory and permanent import tariff shocks, discusses the identification of these shocks, and describes the data and the estimation procedure.

3.1 The Model

The model is cast in latent state-space form. It shares two properties with optimizing dynamic models: one is that the number of shocks can be larger than the number of observable variables; the other is that the identified shocks can have an autoregressive representation. It shares with SVAR models their flexibility in terms of cross-equation parameter restrictions. The baseline model features six unobservable endogenous variables, six transitory shocks, including a transitory import tariff shock, four permanent shocks, including a permanent import tariff shock, and six observables. The advantage of having a rich set of shocks is that tariff shocks compete with other sources of aggregate fluctuations in explaining the data, as in estimated DSGE models.

Let τ_t, y_t, tby_t, i_t, π_t, and moy_t denote, respectively, the import tariff rate, the natural logarithm of real output per capita, the trade-balance-to-output ratio, the nominal interest rate, inflation, and the import-to-output ratio in period t. We assume that these variables can have stochastic trends. Let X_t^τ and X_t^y be the stochastic trends of τ_t and y_t, respectively, X_t^m be the common stochastic trend of i_t and π_t, and X_t^x be the common stochastic trend of moy_t and tby_t. We interpret X_t^τ to be a permanent tariff shock, X_t^y to be a permanent productivity shock, X_t^m to be a permanent monetary shock, and X_t^x to be a permanent external shock. Let $\hat{\tau}_t \equiv \tau_t - X_t^\tau$, $\hat{y}_t \equiv y_t - X_t^y$, $\hat{tby}_t \equiv tby_t - \alpha X_t^x$, $\hat{i}_t \equiv i_t - X_t^m$, $\hat{\pi}_t \equiv \pi_t - X_t^m$, and $\hat{moy}_t \equiv moy_t - X_t^x$ denote the cyclical components of the variables of the model, where α is a parameter to be estimated.[2]

In general, the cyclical components are unobservable, since we do not observe their respective trends.

Let the vector $\hat{Y}_t \equiv [\ \hat{\tau}_t \quad \hat{y}_t \quad \hat{tby}_t \quad \hat{i}_t \quad \hat{\pi}_t \quad \hat{moy}_t\ ]'$. We assume that $\hat{Y}_t$ evolves over time according to

$$\hat{Y}_t = \sum_{i=1}^{L} B_i \hat{Y}_{t-i} + C u_t, \tag{4}$$

where L is the number of lags in the autoregressive component of $\hat{Y}_t$ and u_t is a vector of exogenous shocks. For notational convenience, the presentation of the model omits intercepts. The vector u_t is assumed to be given by

$$u_t \equiv [\ z_t^\tau \quad z_t^y \quad z_t^{tby} \quad z_t^i \quad z_t^\pi \quad z_t^{moy} \quad \Delta X_t^\tau \quad \Delta X_t^y \quad \Delta X_t^m \quad \Delta X_t^x\ ]'.$$

Here z_t^j, for $j = \tau, y, tby, i, \pi, moy$, are stationary shocks. The vector u_t is unobservable and is assumed to follow an AR(1) process of the form

$$u_t = \rho u_{t-1} + \psi \nu_t, \tag{5}$$

where ρ and ψ are diagonal matrices and ν_t is a vector of i.i.d. innovations normally distributed with mean 0 and variance equal to 1.

Letting $\xi_t \equiv [\ \hat{Y}_t' \quad \hat{Y}_{t-1}' \quad \dots \quad \hat{Y}_{t-L+1}' \quad u_t'\ ]'$ be the unobserved state of the system, equa-

[2] If α is equal to 0, then the trade-balance-to-output ratio is stationary (i.e., X_t^x is the common permanent component of the import- and export-to-output ratios), and if α is equal to -1, then the export-to-output ratio is stationary. All other values of α imply that the trade-balance-to-output ratio and the export-to-output ratio are nonstationary.

tions (4) and (5) can be written in companion form as

$$\xi_{t+1} = F\xi_t + \Psi\nu_{t+1}, \tag{6}$$

where the matrix F is a function of B_i, for $i = 1, \ldots, L$, C, and ρ, and the matrix Ψ is a function of C and ψ.

We wish to estimate the elements of the matrices B_i, for $i = 1, \ldots, L$, C, ρ, and ψ. However, equation (6) cannot be directly taken to the data because the state vector ξ_t is not observable. To address this problem, we introduce observable variables for which the model has precise predictions. Specifically, the observable variables included in the estimation are the change in the import tariff rate, $\Delta\tau_t$, the growth rate of real output per capita, Δy_t, the change in the trade-balance-to-output ratio, Δtby_t, the change in the nominal interest rate, Δi_t, the interest-rate-inflation differential, $r_t \equiv i_t - \pi_t$, and the change in the import-to-output ratio, Δmoy_t. The model predicts that these observable variables are linked to the unobservable states of the model by the equations

$$\Delta\tau_t = \hat{\tau}_t - \hat{\tau}_{t-1} + \Delta X_t^{\tau},$$

$$\Delta y_t = \hat{y}_t - \hat{y}_{t-1} + \Delta X_t^{y},$$

$$\Delta tby_t = \hat{tby}_t - \hat{tby}_{t-1} + \alpha\Delta X_t^{x},$$

$$\Delta i_t = \hat{i}_t - \hat{i}_{t-1} + \Delta X_t^{m},$$

$$r_t = \hat{i}_t - \hat{\pi}_t,$$

and

$$\Delta moy_t = \hat{moy}_t - \hat{moy}_{t-1} + \Delta X_t^{x}.$$

These equations can be written compactly as

$$\begin{bmatrix} \Delta\tau_t \\ \Delta y_t \\ \Delta tby_t \\ \Delta i_t \\ r_t \\ \Delta moy_t \end{bmatrix} = H'\xi_t,$$

where H is a matrix containing zeroes, ones, and the parameter α. We assume that the left-hand side of this equation can be observed up to measurement error. Letting the vector

$o_t \equiv [\ \Delta\tau_t^o \quad \Delta y_t^o \quad \Delta tby_t^o \quad \Delta i_t^o \quad r_t^o \quad \Delta moy_t^o\ ]'$ collect the observed realizations of the corresponding variables without the superscript o, we can write

$$o_t = H'\xi_t + \mu_t, \tag{7}$$

where μ_t is a vector of measurement errors. We assume that μ_t is i.i.d., normally distributed with mean zero and a diagonal variance-covariance matrix R, and uncorrelated with ν_t.

Summarising, the model consists of the state equation (6) and the observation equation (7).

3.2 Identification

An important identification issue is whether the import tariff rate, τ_t, is exogenous or responds to the state of the business cycle. We consider two identification schemes: one that treats τ_t as exogenous and one that allows it to respond to macroeconomic conditions. The first identification scheme is motivated by a central theme in international trade maintaining that politics, rather than macroeconomic conditions, is the primary driver of trade policy. See Grossman and Helpman (1994) for a theoretical framework, and Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) for econometric support for that theory.

The view that tariff changes are not systematically linked to the business cycle is also consistent with historical evidence. Irwin (2020) finds that governments have traditionally used tariffs for three main objectives: to raise revenue in nascent national states, to restrict imports and protect domestic producers from foreign competition, and to reach reciprocity agreements that reduce trade barriers. An emblematic example of an exogenous tariff increase in the postwar era is the Nixon 1971 ten-percent import surcharge. Irwin (2013) argues that although other policy measures at the time, such as the closing of the gold window, were expected as a means to stop the drainage of gold reserves, the import surcharge itself came as a surprise imposition.[3] Accordingly, our baseline specification assumes that the import tariff rate, τ_t, is exogenous and driven solely by the transitory and the permanent tariff shocks, z_t^τ and X_t^τ. The second identification scheme assumes endogenous import tariffs. In particular, the import tariff is allowed to feed back from past values of the endogenous variables (output, the trade balance, imports, inflation, and the nominal interest rate). The estimation under this identification scheme is conducted in section 6.3. There we show that

[3]Specifically, Irwin writes "... the import surcharge constituted a unique, unanticipated policy experiment in which the United States imposed an immediate, across-the-board tariff on dutiable imports." Irwin (2013) also quotes passages from Nixon's announcement of the policy on August 15, 1971 that make it clear that the tariff surcharge was intended to be transitory: "As a temporary measure, I am today imposing an additional tax of 10 percent on goods imported into the United States. ... This import tax is a temporary action."

the main results of the paper are robust to this alternative scheme.

It is clear from section 3.1 that the assumed model structure imposes long-run exclusion restrictions that identify the four nonstationary shocks included in the model. In particular, the nonstationary tariff shock X_t^τ is identified because it is the only shock that affects the import tariff in the long run. Likewise, X_t^y, X_t^m, and X_t^x are identified because they are the only shocks that affect, respectively, output; the nominal interest rate and inflation; and the trade-balance-to-output and import-to-output ratios in the long run.

We identify the stationary shock z_t^τ as a stationary tariff shock by imposing that it be the only stationary shock that affects the import tariff rate contemporaneously. Since our focus is on the effects of tariff shocks, we need not assign an economic interpretation to the remaining five stationary shocks, z_t^y, z_t^{tby}, z_t^i, z_t^π, and z_t^{moy}. They are statistically identified by assuming that the submatrix of C consisting of its first 6 columns is lower triangular with diagonal elements equal to 1.

Thus, under the baseline identification scheme, we have that

$$\tau_t = z_t^\tau + X_t^\tau. \tag{8}$$

Equation (8) imposes the following restrictions on the matrices B_i, for $i = 1, \ldots, L$, and C: All elements of the first row of B_i, for $i = 1, \ldots, L$, are zero. And all elements of the first row of C are zero, except for C_{11}, which is equal to 1. Notice that the fact that the coefficient on ΔX_t^τ in the first row of C is restricted to be 0 does not mean that X_t^τ does not affect τ_t on impact. In fact, because $\hat{\tau}_t = \tau_t - X_t^\tau$, a change in X_t^τ affects the tariff one-for-one contemporaneously.

3.3 Data and Estimation

The system defined by equations (6) and (7) is linear and features Gaussian innovations, implying that the likelihood function of the observed data, o_t, has a known form. This allows for the econometric estimation of the model's parameters.

Our baseline specification employs a lag length of two, $L = 2$, which fits the data better than longer lag specifications. For example, it substantially dominates in fit a specification with four lags, which is often used in empirical business-cycle studies based on SVAR models with quarterly data. Specifically, the model with two lags yields a log marginal data density approximately 40 log points higher than a specification with four lags (see Table B1 in Appendix B). One reason why, in the present setup, a specification with two lags is preferred to one with four lags could be that the model explicitly allows the underlying shocks, u_t, to follow an autoregressive process, as in optimizing dynamic models (see equation (5)).

This feature introduces an additional layer of persistence and dynamic responses to shocks, enabling the model to capture serial correlation in the innovations directly and reducing the need for a longer lag structure in the autoregressive representation of the endogenous variables. By contrast, SVAR formulations typically assume that structural innovations are serially uncorrelated, which means that any persistence in the shocks must be absorbed by including additional lags in the autoregressive dynamics. Nevertheless, as we show in section 6.6, the key results are robust to using four lags.

We estimate the model using Bayesian techniques on quarterly U.S. data from 1959:Q2 to 2024:Q4. The starting date is dictated by the availability of import duty data at a quarterly frequency.

We proxy y_t by the log of U.S. real GDP per capita, tby_t by the ratio of net exports of goods and services to GDP, i_t by the federal funds rate, π_t by core CPI inflation, and moy_t by the ratio of imports of goods and services to GDP. Appendix A provides detailed data sources.

We impose normal prior distributions for the estimated parameters of the matrices B_i, for $i = 1, \ldots, L$. In the spirit of the Minnesota prior, for the diagonal elements of B_1, we impose a relatively high prior mean and standard deviation, 0.95 and 0.5, respectively. For the remaining estimated elements of B_i, we impose a prior mean of 0 and a standard deviation of 0.25. We impose normal prior distributions with mean 0 and standard deviation 0.5 for the estimated elements of C. We assume Gamma distributions with unit mean and standard deviation for the diagonal elements of the matrix ψ. For the diagonal elements of ρ defining the serial correlations of stationary shocks, we impose beta prior distributions with a relatively high mean of 0.7 and standard deviation 0.2. For the elements of ρ defining the serial correlations of the changes in the permanent shocks, we impose beta prior distributions with relatively low means of 0.3 and standard deviations of 0.2. For the parameter α defining the cointegration vector between the import-to-output ratio and the trade-balance-to-output ratio we assume a normal prior distribution with mean zero and standard deviation 0.25. This assumption implies that under the prior mean the trade-balance-to-output ratio is stationary. Finally, for the variances of the measurement errors, the diagonal elements of R, we assume uniform prior distributions with lower bound equal to 0 and upper bound equal to 10 percent of the variance of the corresponding observable variable. Table 1 summarizes the prior distributions.

Table 1: Prior Distributions

Parameter	Distribution	Mean	Std. Dev.
Estimated diagonal elements of B_1	Normal	0.95	0.5
Other estimated elements of B_i, $i = 1, \ldots, L$	Normal	0	0.25
Estimated elements of C	Normal	0	0.5
Diagonal elements of ψ	Gamma	1	1
Diagonal elements of ρ (stationary shocks)	Beta	0.7	0.2
Diagonal elements of ρ (permanent shocks)	Beta	0.3	0.2
Estimated element of H (parameter α)	Normal	0	0.25
Diagonal elements of R	Uniform	$\frac{\text{var}(o_t)}{10\times 2}$	$\frac{\text{var}(o_t)}{10\times\sqrt{12}}$

4 Results

We now present the main results of the paper. We begin by examining the effects of transitory and permanent import tariff shocks on inflation, output, the interest rate, and the external accounts. Next, we quantify the contribution of import tariff shocks to regular business cycle fluctuations and during prominent episodes of large tariff increases.

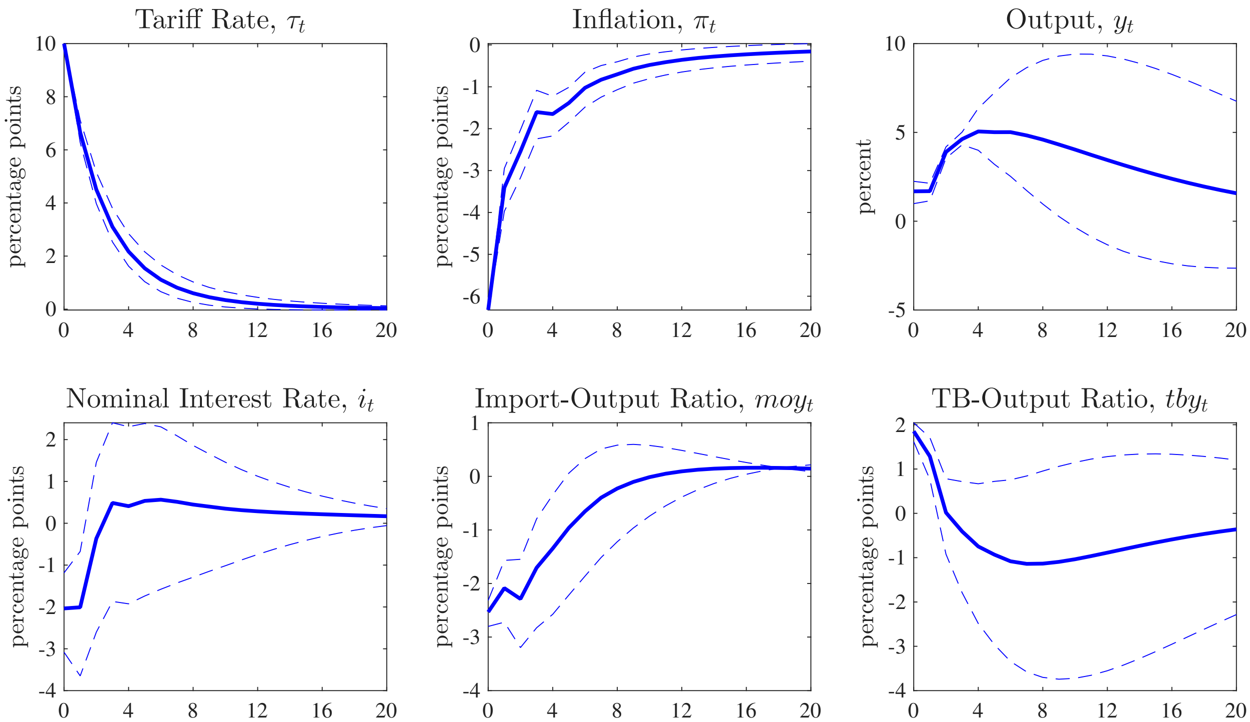
4.1 Estimated Effects of Transitory and Permanent Tariff Shocks

Figure 2 displays posterior mean impulse responses to a ten-percentage-point increase in the transitory import tariff shock, z_t^τ, along with 90-percent posterior credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 draws from an MCMC chain of 1,000,000 draws. The tariff shock is estimated to be short-lived, with a half life of about 2 quarters.

The key result that emerges from Figure 2 is that a temporary increase in the import tariff is neither inflationary nor contractionary. In fact, core inflation falls significantly by 6 annual percentage points on impact and converges gradually from below to its trend level. Output increases by 2 percent on impact, peaks at 5 percent above trend one year after the shock, and remains significantly above trend for about two years. The Fed response is accommodative but short-lived. The federal funds rate falls significantly on impact and one quarter after the shock by about 2 annual percentage points and reaches its trend level in less than a year.

The estimated fall in inflation in response to a transitory increase in import tariffs goes against the conventional wisdom according to which tariff increases are inflationary. We find that the fall in inflation is likely demand driven. To gauge the effect of the transitory tariff shock on domestic demand conditions, Figure 3 displays the response of the consumption-to-output ratio to a 10-percentage-point increase in z_t^τ. To estimate this effect without

Figure 2: Impulse Responses to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^τ



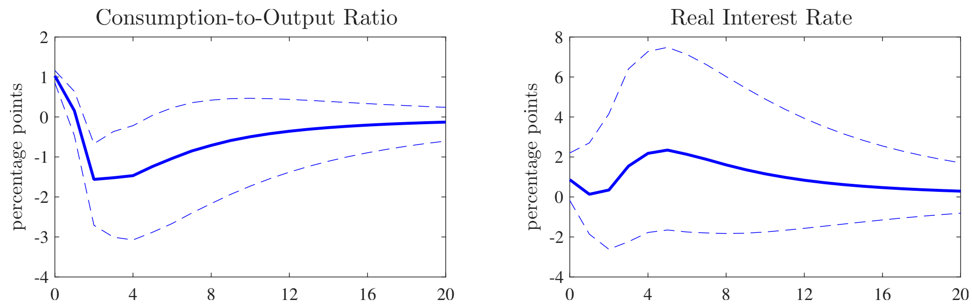
Notes. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are in percent per year.

altering the dimension of the model, we replaced the trade-balance-to-output ratio with the consumption-to-output ratio and reestimated the model. The transitory tariff shock reduces the share of consumption in GDP with some delay. It follows that the estimated expansion in aggregate activity triggered by the temporary tariff hike is not led by an expansion in private consumption. The figure also shows that the real interest rate, $i_t - E_t\pi_{t+1}$, increases after the temporary increase in tariffs, consistent with the hypothesis that the tariff increase lowers aggregate demand. Together with the estimated fall in inflation, this result sheds additional light on possible reasons why the Fed chooses not to tighten in response to the transitory tariff increase.

The tariff hike succeeds in curbing imports (Figure 2). The import-to-output ratio falls significantly by 2.5 percentage points on impact and converges gradually from below to its trend level after about a year. The trade balance experiences a brief improvement of about 2 percentage points on impact and is insignificantly different from its trend level afterwards.

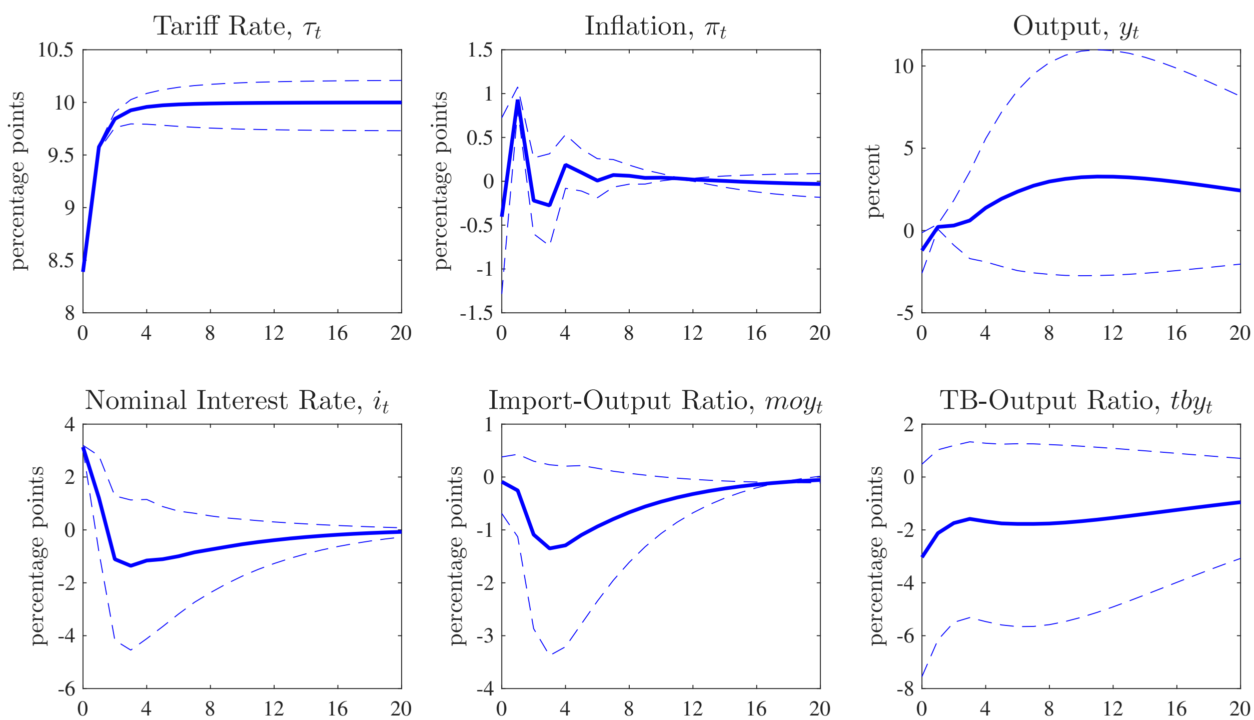
Consider now permanent import tariff shocks. Figure 4 displays impulse responses to a

Figure 3: Impulse Response of the Consumption-to-Output Ratio and the Real Interest Rate to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^τ



Notes. The horizontal axes measure quarters after the shock. Solid lines are posterior mean impulse responses and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. The figure is based on a reestimation of the model after replacing the trade-balance-to-output ratio with the consumption-to-output ratio.

Figure 4: Impulse Responses to a Ten-Percentage-Point Increase in the Permanent Import Tariff Shock, X_t^τ



Notes. The permanent tariff shock increases the import tariff rate by 10 percentage points on average in the long run. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are in percent per year.

Table 2: Variance Decomposition

	$\Delta\tau_t$	Δy_t	Δtby_t	Δi_t	Δmoy_t	$\Delta\pi_t$
z_t^τ	78	2	9	2	6	5
ΔX_t^τ	22	1	10	3	3	1
$z_t^\tau + \Delta X_t^\tau$	100	3	19	5	9	6

Notes. Variance shares are expressed in percent and are posterior means computed from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws.

change in X_t^τ that increases the import tariff by 10 percentage points on average in the long run. Following the X_t^τ shock, the import tariff, τ_t, reaches its new long-run level relatively quickly, in less than half a year. The effects of a permanent change in the import tariff rate on inflation and the nominal interest rate are more in line with conventional wisdom. The 10-percentage-point permanent increase in the import tariff causes a one time inflation spike of about 1 annual percentage point—i.e., a permanent increase in the price level of 0.25 percent. In response to the permanent tariff increase the Fed tightens for one quarter but reverts its action immediately thereafter. The responses of output, imports, and the trade balance are not significantly different from zero. The mute response of the trade balance to a permanent increase in tariffs and its positive response to a transitory increase in tariffs is consistent with the predictions of the intertemporal approach to the current account.

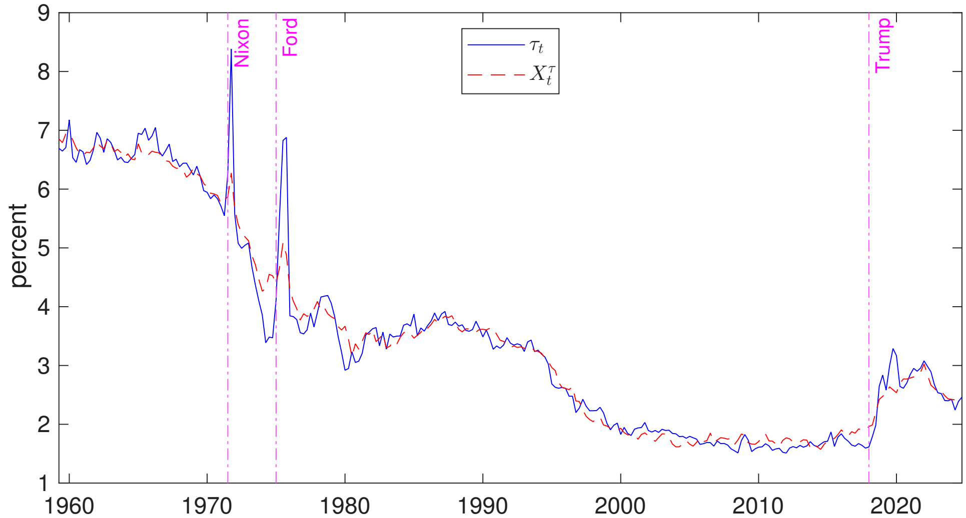
Taken together, Figures 2 and 4 convey a relevant economic message, namely, that transitory and permanent tariff shocks give rise to different dynamics for inflation, output, interest rates and external variables.

This is important for the analysis of episodes of large tariff hikes, because not all come in the same flavor. For example, in section 4.3 we will show that of the main large tariff increases observed between 1959 and 2024 two were mostly transitory (Nixon 1971 and Ford 1975) and one was of a more permanent nature (Trump 2018).

4.2 Are Tariff Shocks Important Drivers of the Regular Business Cycle?

The short answer is no. Table 2 displays the unconditional variance decomposition of the endogenous variables of the model. Three relevant results emerge from this decomposition. First, the transitory tariff shock, z_t^τ, explains the vast majority of changes in tariffs, about 80 percent, leaving only about 20 percent for changes in its trend component, ΔX_t^τ. This finding implies that the impulse responses to transitory tariff shocks, shown in Figure 2, constitute

Figure 5: Predicted Time Path of the Import Tariff and Its Permanent Component



Notes. The variable τ_t denotes the import tariff rate. The variable X_t^τ denotes the permanent component of the import tariff, that is, the import tariff when the transitory import tariff shock, z_t^τ, is turned off. Both paths are computed at the posterior mean of the estimated parameter vector and are net of measurement error. The model interprets the Nixon and Ford tariff shocks (1971:Q3 and 1975:Q1, respectively) as mostly transitory, and the Trump tariff shock (2018:Q1) as more permanent.

the empirically more relevant characterization of the macroeconomic effects of tariff shocks. Those results indicate that typical tariff shocks are not inflationary or contractionary and do not elicit a tightening of money market conditions.

Second, jointly, transitory and permanent movements in tariffs (z_t^τ and ΔX_t^τ) explain a small fraction of the variation in output growth (about 3 percent) and changes in inflation (about 6 percent). Thus, import tariffs are not significant drivers of the regular business cycle. And third, import tariff shocks are more significant drivers of external variables, explaining about 20 percent of changes in the trade-balance-to-output ratio and about 10 percent of changes in the import-to-output ratio.

4.3 Large Tariff Surges: Nixon, Ford, and Trump

We have established that typical import tariff shocks account for only a small share of movements in output and inflation. In this section, we show that even large tariff shocks generate relatively modest movements in real and nominal macroeconomic aggregates. Specifically, we examine the behavior of inflation, output, nominal rates, and imports during the Nixon shock of 1971:Q3, the Ford shock of 1975:Q1, and the Trump shock of 2018:Q1.

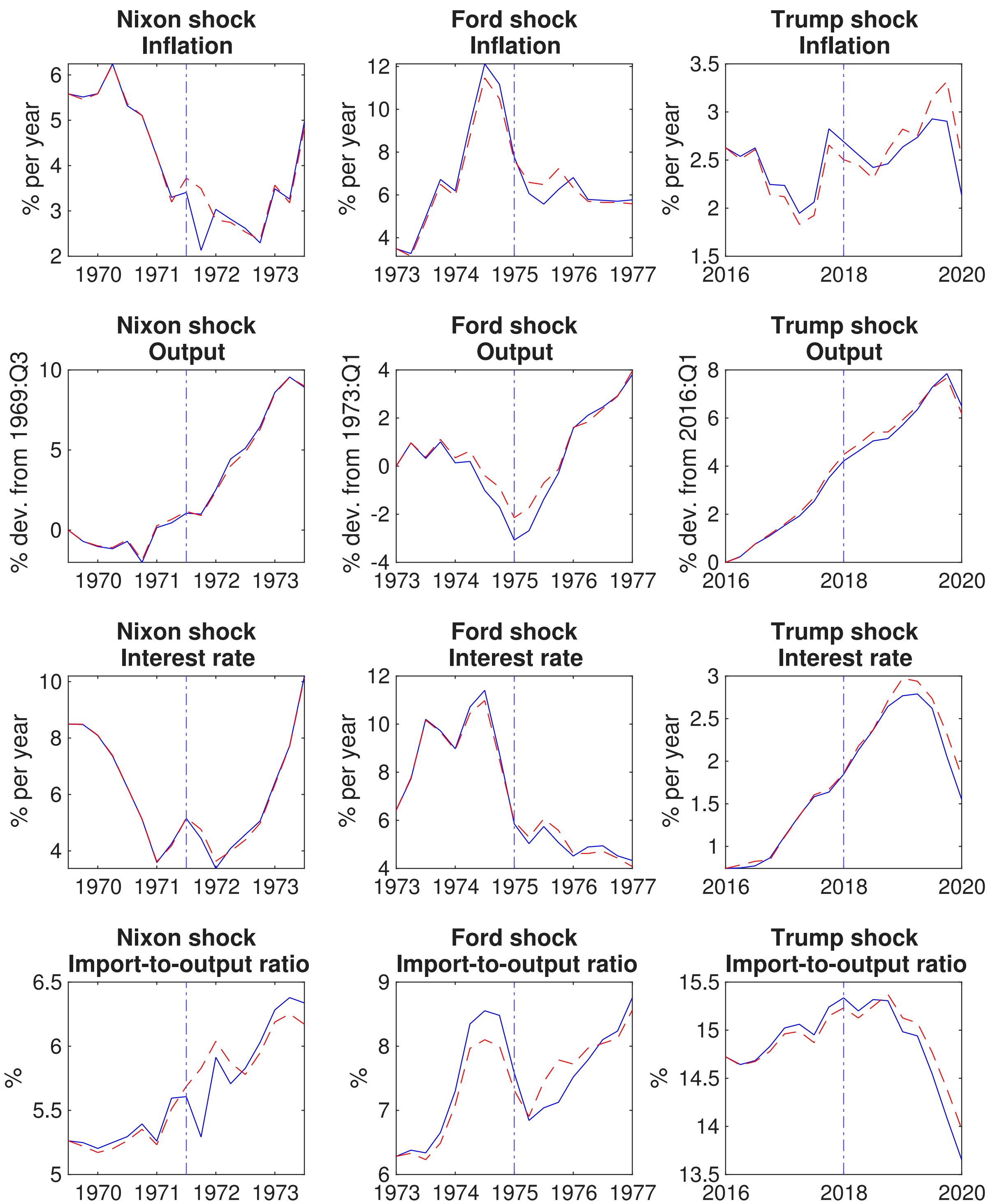
Figure 5 displays, with a solid line, the predicted path of the import tariff when all structural shocks in the model are active. This path closely tracks the actual tariff data, differing only by measurement errors, which we filter out and which are small by construction. Our model allows us to decompose the tariff into its permanent and transitory components. The figure shows the permanent component, X_t^τ, with a dashed line. Thus, the difference between the solid and the dashed line is the transitory tariff shock, z_t^τ.

The model interprets the Nixon and Ford shocks as predominantly transitory and the Trump shock as largely permanent. This classification is consistent with the historical record. President Nixon rescinded the import surcharge in December 1971, only four months after its implementation. Similarly, the Ford administration revoked the $2 oil import fee in December 1975, less than a year after it was introduced. By contrast, the Trump tariffs initiated in 2018 proved more persistent. Owing largely to continued geopolitical tensions with China, President Biden chose to maintain most of the tariffs enacted by President Trump.

How much did these three large tariff hikes affect the macroeconomy? To address this question, Figure 6 depicts the predicted paths of inflation, output, the policy rate, and the import-to-output ratio during these episodes under two assumptions. Solid lines display the dynamics of these variables when all shock realizations take their estimated values. Up to measurement error these paths are identical to the actually observed ones. Dashed lines display dynamics when both the transitory and the permanent tariff shocks (z_t^τ and X_t^τ) are turned off over a four-year window centered around the onset of the tariff hike. The main result that emerges from the figure is that the predicted paths with and without tariff shocks are fairly similar, suggesting that tariff shocks are not a significant driver of aggregate variables even during episodes of large tariff increases.

Having said that, it is worth noting that in all three large tariff hike episodes the behavior of inflation is consistent with our findings that transitory tariff shocks tend to reduce inflation and permanent ones tend to raise it. Specifically, for the two large transitory tariff shocks (Nixon 1971 and Ford 1975), the tariff hike lowered inflation. This can be seen by the fact that in the top left and middle panels of Figure 6, displaying the behavior of inflation during these 2 episodes, the broken line is above the solid line during the tariff increase, indicating that the inflation rate is higher when one turns off the tariff shock. By contrast, during the Trump 2018 shock, which, as argued before, was of a more permanent nature, the broken line is below the solid line for several quarters after the shock (top right panel) implying that inflation is lower than the actual one when the tariff shocks are turned off.

Figure 6: Predicted Paths of Macroeconomic Indicators Around Three Large Tariff Shocks



Notes. Solid lines show paths with all shocks active, and dashed lines show paths with the transitory and permanent tariff shocks (z_t^τ and X_t^τ) shut down. Vertical dash-dotted lines mark the starting dates of the large shocks. Time paths are computed at the posterior mean of the estimated parameter vector and are net of measurement error. The model interprets the Nixon, Ford, and Trump shocks as having modest effects on macroeconomic variables.

5 A Simple Theoretical Model

To shed light on the empirical findings obtained in the preceding econometric analysis, we extend the model of Calvo (1987) to incorporate an import-competing sector. This modification is key to capture the prediction that a temporary increase in import tariffs can cause an expansion in aggregate activity in the context of weakened domestic absorption. We will characterize the effects of temporary, permanent, and anticipated tariff increases.

5.1 The Theoretical Environment

For tractability, we consider a small open economy. Households have preferences over consumption, denoted c_t, and labor effort, denoted h_t, of the form

$$\sum_{t=0}^{\infty} \beta^t [u(c_t) - v(h_t)],$$

where $\beta \in (0, 1)$ is the subjective discount factor. The subutility function u is assumed to be increasing and concave, and the subdisutility function v is assumed to be increasing and convex.

The consumption good is importable. Households are endowed with a constant amount of an exportable good, denoted x, which is not consumed domestically. The consumption good can be imported, but there is also a domestic industry that competes with imported goods. Imported and exported goods trade in the international market at a constant foreign-currency price normalized to 1.

The government imposes a tariff on imports denoted τ_t. The law of one price holds, so the domestic price of the importable consumption good, denoted P_t, is

$$P_t = (1 + \tau_t)\mathcal{E}_t,$$

and the domestic nominal price of the exportable endowment is $\mathcal{E}_t$, where $\mathcal{E}_t$ is the nominal exchange rate, defined as the price of foreign currency in terms of domestic currency, so that an increase in $\mathcal{E}_t$ indicates that the domestic currency depreciates.

Households can trade in a foreign-currency denominated bond, denoted b_t^*, that pays the constant interest rate r^* and in a domestic-currency denominated bond, denoted B_t, that pays the nominal interest rate i_t. The household's sequential budget constraint is then given by

$$P_t c_t + \mathcal{E}_t b_t^* + B_t = \mathcal{E}_t (1 + r^*) b_{t-1}^* + (1 + i_{t-1}) B_{t-1} + W_t h_t + \mathcal{E}_t x + \Phi_t,$$

where W_t denotes the nominal wage rate and Φ_t denotes the sum of transfers received from the government and profits received from the ownership of domestic firms. The domestic bond is redundant, but it is added to determine the nominal interest rate. Letting $p_t \equiv P_t/\mathcal{E}_t$ be the relative price of the import good in terms of export goods (the domestic terms of trade), we have that

$$p_t = 1 + \tau_t. \tag{9}$$

The household's budget constraint can then be written in units of export goods as

$$p_t c_t + b_t^* + b_t = (1+r^*)b_{t-1}^* + \frac{1+i_{t-1}}{1+\epsilon_t} b_{t-1} + w_t h_t + x + \phi_t,$$

where $b_t \equiv B_t/\mathcal{E}_t$ is the real value of domestic bonds, $\epsilon_t \equiv \mathcal{E}_t/\mathcal{E}_{t-1} - 1$ is the nominal depreciation rate, $w_t \equiv W_t/\mathcal{E}_t$ is the real wage, and $\phi_t \equiv \Phi_t/\mathcal{E}_t$ is the real value of transfers and profits.

The household chooses c_t, h_t, b_t^*, and b_t to maximize its utility function subject to the above budget constraint and to a no-Ponzi-game constraint. Letting $\beta^t \lambda_t$ be the Lagrange multiplier associated with the sequential budget constraint, the first-order conditions with respect to c_t, h_t, b_t^*, and b_t are, respectively,

$$u'(c_t) = \lambda_t p_t \tag{10}$$

$$\frac{v'(h_t)}{u'(c_t)} = \frac{w_t}{p_t}, \tag{11}$$

$$\lambda_t = \beta(1+r^*)\lambda_{t+1}, \tag{12}$$

and

$$1 + i_t = (1+\epsilon_{t+1})(1+r^*). \tag{13}$$

The firm producing the import-competing good uses labor as an input. Its production function is $F(h_t)$, where F is positive, increasing, and concave. Profits in units of export goods are given by

$$p_t F(h_t) - w_t h_t,$$

and the firm's profit maximization condition is

$$F'(h_t) = \frac{w_t}{p_t}. \tag{14}$$

The government is assumed to rebate to households in a lump-sum fashion any revenue collected by the tariff. Without loss of generality, we assume that domestic-currency-denominated bonds are in zero net supply, $b_t = 0$ for all t. The country's resource constraint is then given by

$$b_t^* = (1 + r^*)b_{t-1}^* + x + F(h_t) - c_t.$$

Iterating this expression forward and imposing the transversality condition gives

$$(1 + r^*)b_{-1}^* = \sum_{t=0}^{\infty}(1 + r^*)^{-t}[c_t - F(h_t) - x]. \tag{15}$$

We can then define a competitive equilibrium as follows:

Definition 1 (Competitive Equilibrium) *A competitive equilibrium is a set of sequences* $\{c_t, h_t, b_t^*, p_t, \lambda_t, w_t, \epsilon_t, \tau_t, i_t\}_{t=0}^{\infty}$ *satisfying equations (9)-(15), given a monetary policy, a tariff policy, and the initial condition* b_{-1}^*.

Other variables of interest can be readily derived: Imports, denoted m_t, are given by

$$m_t = c_t - F(h_t). \tag{16}$$

The trade balance, denoted tb_t, is given by

$$tb_t = x - m_t. \tag{17}$$

Output measured at world prices, denoted y_t, is given by

$$y_t = F(h_t) + x. \tag{18}$$

The consumer price inflation rate, denoted $\pi_t \equiv P_t/P_{t-1} - 1$, is given by

$$\pi_t = (1 + \epsilon_t)\frac{1 + \tau_t}{1 + \tau_{t-1}} - 1. \tag{19}$$

Finally, the domestic real interest rate, denoted r_t, and defined as the difference between the domestic nominal interest rate, i_t, and next period's consumer price inflation, π_{t+1}, satisfies

$$r_t = (1 + r^*)\frac{1 + \tau_t}{1 + \tau_{t+1}} - 1. \tag{20}$$

From this expression, it is clear that a transitory tariff increase raises the domestic real rate, an anticipated future tariff increase lowers it, and a permanent tariff increase leaves it unchanged. Thus in the first case households have incentives to postpone consumption, in the second case to frontload consumption, and in the third case there is no incentive for intertemporal substitution.

5.2 A Temporary Tariff Increase

Suppose that prior to period 0, the economy was in a steady state with an import tariff equal to 0, $\tau_t = 0$ for all $t < 0$. Assume further that in period zero the government unexpectedly imposes an import tariff equal to $\tau > 0$ for just that period. Thus, the path of τ_t is given by

$$\tau_t = \begin{cases} 0 & \text{for } t < 0 \\ \tau & \text{for } t = 0 \\ 0 & \text{for } t > 0 \end{cases}. \tag{21}$$

To avoid inessential dynamics, assume that the subjective and world discount rates are equal to each other, $\beta(1 + r^*) = 1$. It then follows from equilibrium condition (12) that λ_t is constant over time, $\lambda_t = \lambda_0$ for $t > 0$. Then, from (9) and (10) we have that

$$u'(c_t) = \lambda_0(1 + \tau_t)$$

Since $u'' < 0$, this expression and the path of the import tariff given in (21) imply that consumption is lower in period 0 than in all other future periods and that consumption is constant from period 1 on, $c_t = c_1 > c_0$, for $t > 1$. Intuitively, the tariff makes importables relatively more expensive in period 0 than in any other future period, so households substitute future consumption for current consumption.

Combining the labor supply schedule of households, equation (11), and the labor demand schedule of import-competing producers, equation (14), we have that

$$F'(h_t) = \frac{v'(h_t)}{u'(c_t)}, \tag{22}$$

which implicitly defines hours as a decreasing function of consumption. Given the equilibrium path of c_t, the above expression implies that hours are higher in period 0 than in any future period and that hours are constant after period 1, $h_t = h_1 < h_0$, for $t > 1$. In turn, the definition of imports, equation (16), and the equilibrium paths of c_t and h_t imply that imports are lower in period 0 than in any future period and are constant starting in period 1, $m_t = m_1 > m_0$, for $t > 1$. Similarly, equation (17) and the equilibrium path of m_t imply that the trade balance is larger in period 0 than in any future period and constant starting in period 1, $tb_t = tb_1 < tb_0$, for $t > 1$. The resource constraint (15) implies that in the pre-tariff steady state, the trade balance is given by $tb_{-1} = -r^* b^*_{-1}$. Intuitively, the economy can afford a trade deficit equal to the interest flow generated by its net foreign asset position. Then, we can write the intertemporal resource constraint (15) as

$$tb_{-1} = \frac{r^*}{1+r^*}\sum_{t=0}^{\infty}(1+r^*)^{-t}tb_t. \tag{23}$$

Since the trade balance is constant starting in period 1, we can rewrite (23) as

$$tb_{-1} = \frac{r^*}{1+r^*}tb_0 + \frac{1}{1+r^*}tb_1. \tag{24}$$

This shows that tb_{-1} is a weighted average of tb_0 and tb_1. Since we have already demonstrated that $tb_0 > tb_1$, it follows immediately that $tb_0 > tb_{-1}$, or that

$$\Delta tb_0 > 0.$$

It follows directly from (17) that imports fall in period 0,

$$\Delta m_0 < 0.$$

This result, together with equation (16) and the fact that h and c are inversely related (see equation (22)), implies that in period 0 consumption falls and hours increase,

$$\Delta c_0 < 0$$

and

$$\Delta h_0 > 0.$$

Finally, equation (18) and the fact that in period 0 hours worked increase imply that output expands in period 0,[4]

$$\Delta y_0 > 0.$$

From equation (20) it follows that the domestic real interest rate rises in period 0,

$$\Delta r_0 > 0.$$

Summarizing, we have shown that the theoretical model predicts that a transitory tariff increase expands output, lowers imports, improves the trade balance, and raises the real interest rate. These predictions of the theoretical model are qualitatively consistent with

[4]Output at market prices, $p_0F(h_0) + x$, also increases because p_0 rises with the import tariff rate.

the estimated responses of these variables to a transitory tariff increase. In particular, these results show that in a model with an import-competing industry, a transitory tariff increase need not be contractionary even if domestic absorption is negatively affected by the tariff.

It remains to discuss the behavior of inflation and the nominal interest rate. Both variables clearly depend on the stance of monetary policy. Importantly, a temporary tariff increase does not necessarily generate inflation. To illustrate this point, we consider a monetary authority that, upon the realization of the tariff shock, adjusts its policy in a way that prevents the shock from passing through to consumer prices. Interestingly, we will show that this entails looking through the tariff shock, that is, the central bank need not tighten money market conditions to prevent prices from rising.

From equation (19), we have that if the central bank is to keep inflation from increasing in period 0, $\Delta\pi_0 = 0$, it needs to let the exchange rate appreciate to offset the tariff shock:

$$1 + \epsilon_0 = \frac{1 + \epsilon_{-1}}{1 + \tau_0} < 1 + \epsilon_{-1}.$$

This policy ensures that $\pi_0 = \pi_{-1}$, that is, that $\Delta\pi_0 = 0$. Suppose that in period 1, the central bank returns to a depreciation rate equal to the one prevailing in the pre-tariff steady state, that is $\epsilon_t = \epsilon_{-1}$, for $t > 0$. Then, by the domestic Euler equation (13), we have that

$$1 + i_0 = (1 + \epsilon_1)(1 + r^*) = (1 + \epsilon_{-1})(1 + r^*) = 1 + i_{-1}.$$

In words, in order to prevent the tariff from causing price inflation, the central bank keeps the nominal rate constant, $\Delta i_t = 0$, looking through the tariff shock.

In period 1, the inflation rate is below its pre-tariff level. To see this, evaluate equation (19) at $t = 1$ to get

$$1 + \pi_1 = \frac{1 + \epsilon_1}{1 + \tau_0} = \frac{1 + \epsilon_{-1}}{1 + \tau_0} < 1 + \epsilon_{-1} = 1 + \pi_{-1}.$$

From period 2 onward, the inflation rate is constant and equal to its pre-tariff steady-state value π_{-1}. It follows that the tariff shock is not inflationary and does not induce a monetary tightening, which is in line with the estimated predictions of the econometric model.

5.3 A Permanent Tariff Increase

Suppose now that the unexpected increase in the import tariff in period 0 is permanent,

$$\tau_t = \begin{cases} 0 & \text{for } t < 0 \\ \tau & \text{for } t \geq 0 \end{cases}. \tag{25}$$

As before, we have from the household's Euler equation for international bonds, equation (12), that λ_t is constant starting in period 0. Equations (9) and (25) imply that the domestic terms of trade, p_t, are constant starting in period 0. Equation (10) then implies that consumption, c_t, is constant starting in period 0. Intuitively, because the tariff is constant over time, it does not distort the intertemporal relative price of the imported good, and therefore does not induce a reallocation of expenditures across time. An analysis analogous to the one performed in the case of a temporary tariff increase then implies that h_t, m_t, tb_t, and y_t are constant starting in period 0.

Finally, equation (23) and the fact that the trade balance is constant from period 0 on imply that $tb_{-1} = tb_0$. That is, the trade balance is unaffected by the tariff shock in period 0, $\Delta tb_0 = 0$. Following the same steps as in the analysis of a temporary tariff shock, we readily deduce that no real variable is affected by the permanent tariff shock, $\Delta c_0 = \Delta m_0 = \Delta y_0 = 0$. This result is consistent with the estimated responses of the econometric model.

The effect of the tariff shock on inflation depends on how much of the shock the central bank allows to pass through to prices, and on how it chooses to distribute that pass-through over time. The estimated empirical model suggests that the central bank allows some of the tariff to pass through to prices in the form of a one-off increase in the price level, with a short delay. It also estimates a tightening of money market conditions on impact. In the theoretical model, this requires an initial appreciation of the currency similar in size to the tariff shock, so that $\Delta\pi_0 = 0$. Delaying the pass-through by one period requires a tightening in period 0, $\Delta i_0 > 0$, as estimated by the empirical model. To see this, note that by equations (13) and (19) evaluated at $t = 1$, we have that $\Delta\pi_1 = \Delta\epsilon_1 = \Delta i_0/(1 + r^*)$.

5.4 An Anticipated Tariff Increase

Finally, suppose that in period 0 agents learn that in period 1 a tariff will be imposed:

$$\tau_t = \begin{cases} 0 & \text{for } t \leq 0 \\ \tau & \text{for } t \geq 1 \end{cases}. \tag{26}$$

It continues to be the case that by the Euler equation, equation (12), $\lambda_t = \lambda_0$. The first-order condition with respect to consumption, equation (10), together with the fact that the domestic terms of trade equal the tariff rate, equation (9), then implies that $c_0 > c_1$ and that $c_t = c_1$ for all $t \geq 1$. Anticipating the higher relative price of consumption goods in the future, demand expands in period 0. With higher demand, it follows from equilibrium conditions (11) and (14) that employment in the import-competing industry falls in period 0 and will be higher once the tariff is imposed, that is, $h_1 > h_0$. Furthermore, from period 1 onward employment is constant, $h_t = h_1$ for all $t \geq 1$. In turn, with consumption higher and domestic production lower in period 0 than in period 1, we have that in period 0 imports rise and the trade balance deteriorates relative to period 1, $tb_0 < tb_1$ and $m_0 > m_1$. This is intuitive: imports should rise in anticipation of future higher tariffs.

From period 1 onward, consumption and hours are constant and equal to their period-1 values, so that $m_t = m_1$ and $tb_t = tb_1$ for all $t \geq 1$. Thus, equation (24) holds also for the anticipated tariff case, and because $tb_1 > tb_0$, it must be that $\Delta tb_0 < 0$. Since, as we established earlier, the trade balance is decreasing in domestic absorption, it follows that $\Delta c_0 > 0$, that is, in response to the anticipated tariff hike domestic demand rises. Employment, being negatively related to demand, falls, and hence domestic output also falls, $\Delta h_0 < 0$ and $\Delta y_0 < 0$.

The behavior of inflation and the nominal rate again depends on the stance of monetary policy. It is possible for the model to predict that, in response to the tariff news, both inflation and the nominal interest rate rise, as we estimate in section (6.1) below. This would require that the monetary authority depreciates the currency in periods 0 and 1.

Summing up, the analysis in this section shows that the predictions of the estimated econometric model are qualitatively consistent with those of an optimizing open economy model featuring an import-competing sector. Specifically, like the empirical model, the theoretical model predicts that a transitory increase in import tariffs is not contractionary or inflationary, improves the trade balance, and depresses imports and domestic absorption relative to output. Also consistent with the results obtained from the estimation of the empirical model, the theoretical model predicts that a permanent tariff increase leaves output, imports, and the trade balance largely unchanged, while inducing a brief monetary tightening and a one-off increase in the price level. As we will show in section (6.1) below, the responses predicted by the theoretical model to an anticipated future tariff increase are also qualitatively consistent with their estimated counterparts. In particular, anticipated tariff increases tend to depress output, raise demand, raise imports, and deteriorate the trade balance.

6 Additional Results and Robustness Analysis

This section presents additional results and a number of robustness checks. First, we extend the empirical model to include anticipated tariff shocks. Second, we show that the response of the real exchange rate to tariff shocks is imprecisely estimated, making it not particularly useful for discriminating among alternative theoretical models. Third, we relax the assumption that import tariff rates are exogenous and allow them to respond to macroeconomic conditions. Fourth, we add as observables the two alternative tariff measures constructed in section 2, namely the trade-restrictiveness index and the fixed-weight import tariff rate. Fifth, we examine whether the results are affected by the Nixon price controls. Finally, we extend the lag length of the autoregressive component of the model from two to four quarters.

6.1 Anticipation

A common concern with the identification of tariff shocks is that they may be anticipated. To address this issue, we allow the transitory and permanent tariff shocks, z_t^τ and X_t^τ, to be driven by anticipated as well as unanticipated innovations. Specifically, if news about a future tariff increase is revealed in period t, but materializes in an increase in the import tariff only in period $t+j$, it can have real and nominal effects already in period t.

Recalling that the tariff rate is given by $\tau_t = z_t^\tau + X_t^\tau$, we assume that z_t^τ and ΔX_t^τ follow the laws of motion

$$x_t = \rho_x x_{t-1} + \sum_{j=0}^{J} \sigma_j^x \nu_{j,t-j}^x, \tag{27}$$

for $x = z^\tau, \Delta X^\tau$, where J denotes the longest anticipation horizon. Here $\nu_{j,t}^x$ for $j = 0, 1, \ldots, J$ are tariff innovations that are anticipated j periods in advance and are assumed to distribute normal i.i.d. with mean zero and unit variance. The scalars σ_j^x are assumed to be positive and define the standard deviations of the respective tariff innovations. If $J = 0$, then the model collapses to the baseline formulation, featuring no anticipated tariff shocks. An advantage of our econometric approach is that it allows for the joint estimation of transitory and permanent unanticipated and anticipated shocks with multiple anticipation horizons.

All other shocks of the model follow the laws of motion assumed in the baseline specification as described in equation (5) in section 3. The tariff news $\nu_{j,t}^x$ for $j > 0$ is identified by imposing that it cannot affect the import tariff rate prior to period $t+j$ and that it can affect all other variables of the model (output, inflation, the interest rate, imports, and the trade balance) starting in period t.

Table 3: Log Marginal Data Densities for Models with Anticipated Tariff Shocks

	Quarters of Anticipation								
p	[0]	[0,1]	[0,2]	[0,3]	[0,4]	[0,8]	[0,1,2]	[0,1,2,3,4]	[0, 4, 8]
0.1	-1303.3	-1317.5	-1307.6	-1311.2	-1304.8	-1307.7	-1318.2	-1352.8	-1320.5
0.2	-1302.8	-1316.8	-1308.1	-1310.6	-1306.0	-1307.0	-1318.7	-1352.4	-1321.2
0.3	-1302.5	-1316.4	-1308.0	-1310.3	-1305.6	-1306.7	-1318.6	-1352.3	-1320.8
0.4	-1302.3	-1316.1	-1307.9	-1310.1	-1305.3	-1306.4	-1319.1	-1352.4	-1320.5
0.5	-1302.1	-1315.9	-1307.8	-1310.0	-1305.1	-1306.2	-1319.1	-1352.7	-1320.5
0.6	-1302.0	-1315.7	-1307.6	-1309.9	-1304.9	-1306.0	-1319.0	-1353.4	-1320.3
0.7	-1302.0	-1315.5	-1307.5	-1310.4	-1304.8	-1305.9	-1318.9	-1353.3	-1320.1
0.8	-1301.9	-1315.4	-1307.4	-1310.3	-1304.6	-1305.7	-1318.7	-1353.2	-1320.0
0.9	-1301.8	-1315.3	-1307.3	-1310.1	-1304.6	-1305.6	-1318.6	-1353.1	-1319.9

Notes. The variable p denotes the truncation parameter of the chi-squared auxiliary density. Columns represent the anticipation structure. For example, [0,4] means that the model includes transitory and permanent tariff shocks anticipated 0 and 4 quarters; and [0,4,8] means that the model includes tariff shocks anticipated 0, 4, and 8 quarters. The baseline specification is shown in the column labeled [0].

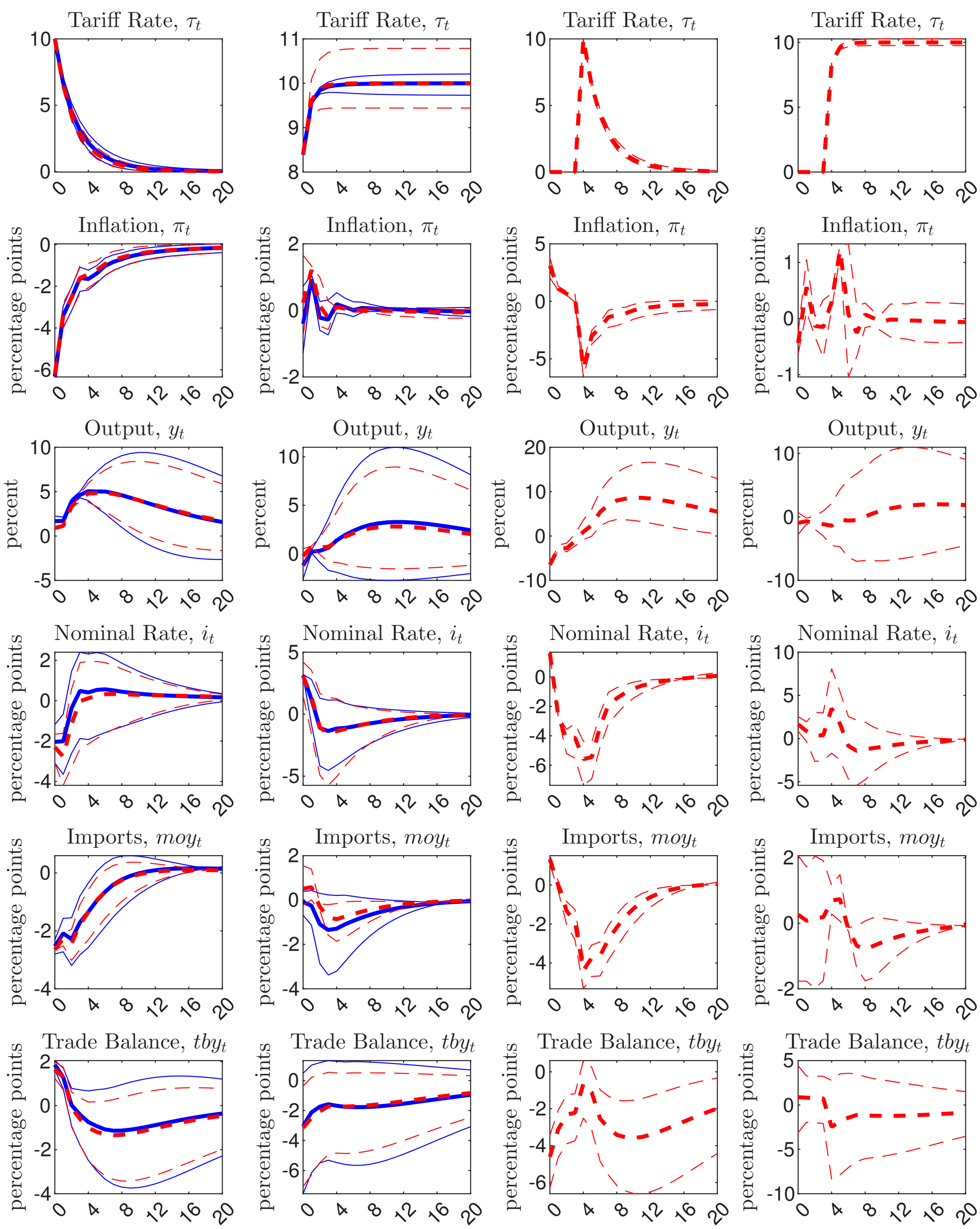
The standard deviations of the news shocks, σ_j^x, for $j = 1, \ldots, J$ and $x = z^\tau, \Delta X^\tau$, are assumed to have the same prior distributions as the standard deviations of the unanticipated shocks, namely, a Gamma distribution with mean and standard deviation equal to unity, see Table 1. The coefficients of the new (expanded) C matrix defining the impact effect of the news shocks on the cyclical components of the endogenous variables of the model are assumed to have a normal prior distribution with mean zero and standard deviation 0.5, which is the same prior distribution as the one assumed for the impact effect of the unanticipated shocks. The coefficients of the first row of C corresponding to the news shocks, i.e., the loadings of the tariff rate on the news shocks, are zero by definition.

We begin by testing whether including anticipation improves model fit. The test consists in comparing log marginal data densities for models with different anticipation structures. The maximum anticipation horizon considered is 8 quarters ($J \leq 8$). Table 3 shows that the preferred specification is the one without anticipation ($J = 0$), that is, the baseline model.

Notwithstanding the result that a specification without news is statistically preferred to one with news, we explore the predictions of a model with news. Specifically, we select the specification that, conditional on allowing for news, has the highest log marginal data density. According to Table 3, this is the specification with 0 and 4 quarters of anticipation.

We begin by ascertaining whether the estimated impulse responses to unanticipated tariff shocks are robust to adding news shocks. The first two columns of Figure 7 show the responses to unanticipated transitory and permanent tariff shocks for two specifications:

Figure 7: Impulse Responses With and Without Anticipated Shocks



Notes. Horizontal axes measure quarters after the shock. Bold solid lines are posterior means and thin solid lines are 90-percent credible bands in the baseline model (no anticipation). Bold dashed lines are posterior means and thin dashed lines are 90-percent credible bands in the model with 0- and 4-quarter anticipated tariff shocks. Column 1: unanticipated temporary tariff shock, $\nu_{0,t}^{z^\tau}$. Column 2: unanticipated permanent tariff shock, $\nu_{0,t}^{X^\tau}$. Column 3: 4-quarter anticipated temporary tariff shock, $\nu_{4,t}^{z^\tau}$. Column 4: 4-quarter anticipated permanent tariff shock, $\nu_{4,t}^{X^\tau}$. Row 5: import-to-output ratio. Row 6: trade-balance-to-output ratio. Posterior means and 90-percent credible bands are computed from a random subsample of size 100,000.

Table 4: Anticipated Tariff Shocks: Variance Decomposition

Share	$\Delta\tau_t$	$\Delta\pi_t$	Δy_t	Δi_t	Δmoy_t	Δtby_t
	Baseline					
Unanticipated	100.0	6.3	3.1	5.0	8.9	18.9
	0 and 4 Quarter Anticipation					
Unanticipated	58.0	3.6	1.6	3.4	5.6	9.7
4 Qrts Anticipated	42.0	4.8	4.7	4.9	7.9	18.7
Total	100.0	8.5	6.3	8.3	13.5	28.4

Notes. Baseline refers to the model without anticipated tariff shocks and reproduces the corresponding results from Table 2.

the model that includes 0- and 4-quarter anticipated shocks (dashed lines) and the baseline model, which includes only 0-quarter anticipation (solid lines). The figure shows that the estimated impulse responses of inflation, output, nominal rates, imports, and the trade balance are robust to allowing for news shocks. In particular, an unanticipated transitory tariff increase continues to be neither inflationary nor contractionary, is not associated with a monetary tightening, lowers imports, and improves the trade balance. Similarly, the estimated impulse responses to an unanticipated permanent tariff increase are robust to the addition of tariff news shocks.

Second, we characterize the impulse responses to transitory and permanent tariff news shocks. The last two columns of Figure 7 display the responses to 4-quarter anticipated transitory and permanent tariff shocks. Interestingly, the anticipated transitory import tariff shock is inflationary and worsens the trade balance, which is consistent with an intertemporal reallocation of domestic absorption in anticipation of the expected future tariff increase. This effect can be captured theoretically in a framework like the one developed in section 5. The figure also shows that the anticipated transitory tariff increase causes a fall in output. This is also consistent with the optimizing model of section 5: if domestic absorption (c_t) goes up upon the news of future tariff increases, the supply of labor shrinks, causing a reduction in output in the import-competing sector (see equation (22)). Our estimated effects of anticipated tariff shocks are furthermore consistent with the empirical results in Barattieri, Cacciatore, and Ghironi (2021), who find that initiations of antidumping investigations in Canada, which we interpret as anticipated tariff increases, are inflationary and contractionary.

The last column of Figure 7 suggests that the responses to permanent anticipated tariff shocks are imprecisely estimated.

Finally, Table 4 displays the contribution of tariff shocks to the variance of the variables of the model. It shows that tariff news shocks account for about 40 percent of the unconditional variance of tariff changes, and unanticipated tariff shocks explain about 60 percent. The table also shows that tariff news shocks are more important than unanticipated tariff shocks at explaining the variance of endogenous variables. However, tariff shocks continue to be a minor driver of the U.S. business cycle: taken together anticipated and unanticipated tariff shocks explain less than 10 percent of the variance of domestic variables (inflation, output, and the nominal interest rate).

6.2 Import Tariffs and the Real Exchange Rate

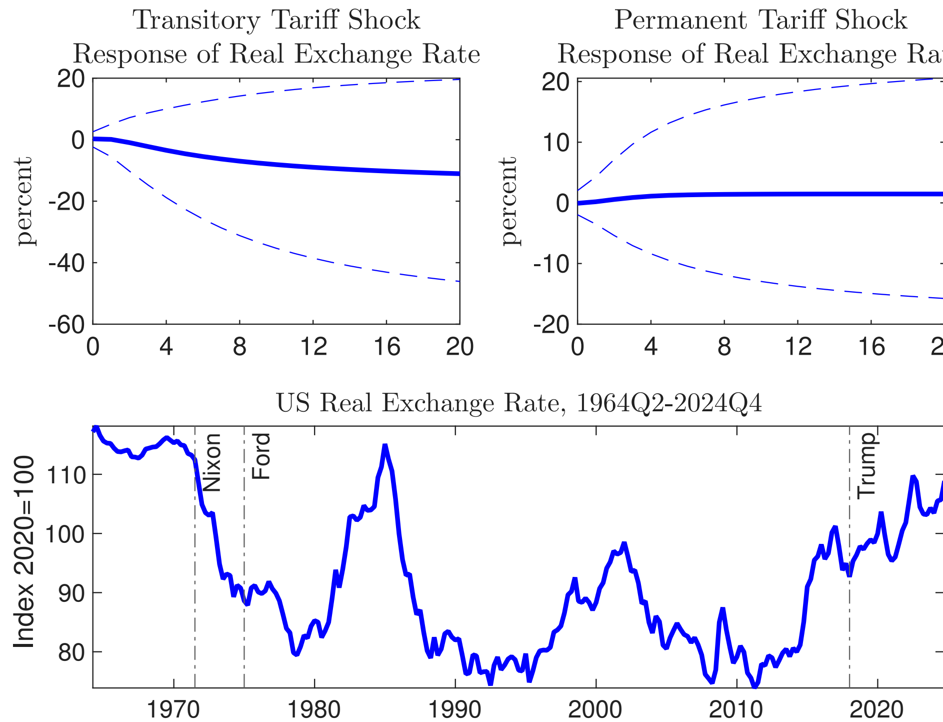
Do increases in U.S. import tariffs affect U.S. competitiveness? Equivalently, do tariff hikes make the U.S. economy cheaper or more expensive relative to other countries or neither? To address this question, we estimate a variant of the empirical model that includes the real exchange rate as an observable. We define the real exchange rate as the ratio of the U.S. consumer price level to the exchange-rate adjusted foreign consumer price level, so that an increase in the real exchange rate means that the dollar appreciates in real terms or that the United States becomes more expensive vis-à-vis the rest of the world.

Specifically, the real exchange rate is measured by the narrow (27 economies) real effective exchange rate index produced by the Bank of International Settlements (BIS, 2025). This index is the geometric trade-weighted average of 27 bilateral real exchange rates. The sample period is 1964:Q1 to 2024:Q4. Because the sample for the other observables included in the model starts earlier, in 1959:Q1, we treat observations of the real exchange rate over the period 1959:Q1 to 1963:Q4 as missing observations. We assume that the log-difference of the real exchange rate is stationary. To maintain the dimension of the model, we eliminate from its baseline specification the trade-balance-to-output ratio and replace it with the log difference of the real exchange rate.

The top panels of Figure 8 display the response of the level of the real exchange rate to a temporary and a permanent increase in the import tariff rate of 10 percentage points. The key message that emerges from these impulse responses is that import tariff shocks have no significant effect on U.S. competitiveness. The 90-percent error bands around the point estimates of the impulse responses are wide and span the range (-30,+15) for the temporary shock and (-10,+15) for the permanent shock at the 8-quarter horizon. This result is relevant because a common view is that import tariffs tend to appreciate the dollar in real terms (e.g., make the U.S. more expensive relative to other countries.).

Looking at the raw data (bottom panel of Figure 8) conveys a similar message. There seems to be no readily detectable relationship between major tariff events and the real exchange rate: The Nixon 1971 and Ford 1975 tariff shocks took place during a depreciation

Figure 8: U.S. Import Tariffs and the Real Exchange Rate



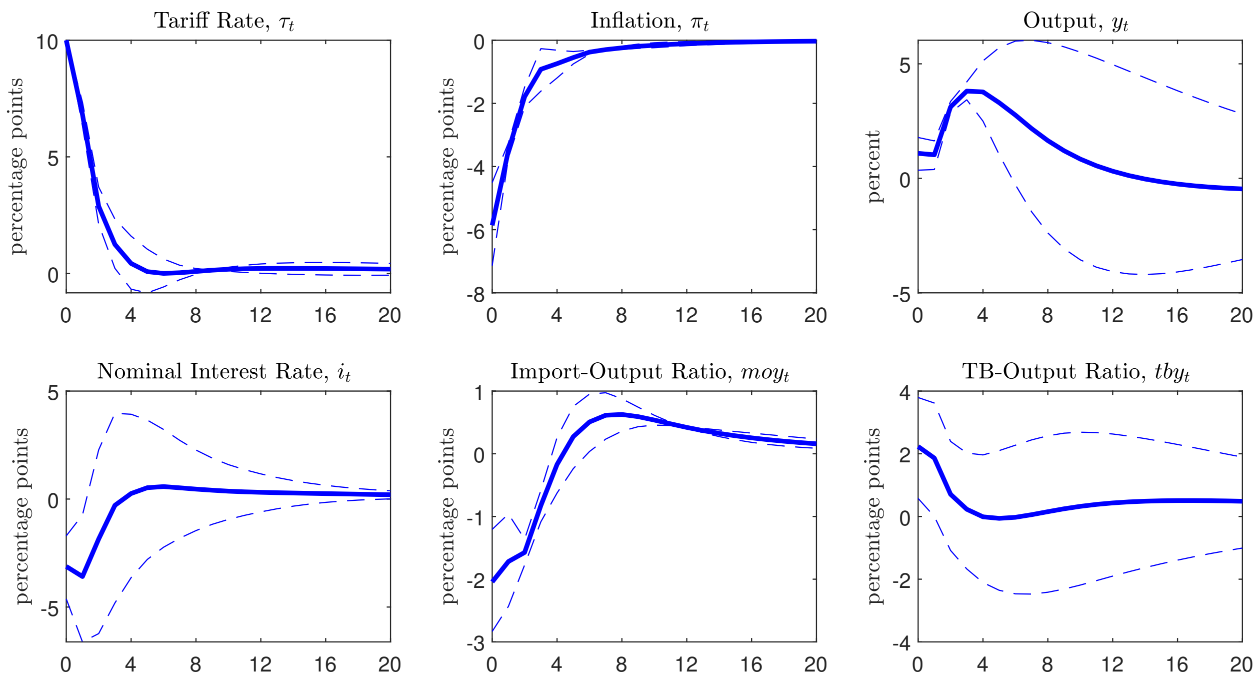
Notes. In the top panels horizontal axes measure quarters after the shock, and vertical axes measure percent deviations from the pre-shock level. Solid lines are posterior means impulse responses and dashed lines mark 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. The bottom panel displays with a solid line the actual US. real effective exchange rate, and with dashed vertical lines major tariff episodes. In all panels of the figure, an increase in the real exchange rate indicates a real appreciation of the U.S. dollar.

phase of the real exchange rate that started around 1970 and ended around 1980. Neither shock appears to have modified this trajectory. Similarly, the first Trump tariff shock of 2018 happened during an appreciation phase that started after the global financial crisis (circa 2012) and was still ongoing by the end of the sample (2024:Q4). Again, this tariff shock does not appear to have altered the trajectory of the real exchange rate.

6.3 Endogenous Import Tariff

The baseline specification assumes that import tariffs follow an exogenous process with transitory and permanent shocks, z_t^τ and X_t^τ, as shown in equation (8). As discussed in section 3.2, this assumption is motivated by an important line of research in international trade suggesting that the key reasons for import tariff changes are not linked to the state of the business cycle.

Figure 9: Impulse Responses to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^{τ}, in a Model with Endogenous Import Tariffs



Notes. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are in percent per year.

To assess whether this exogeneity assumption is restrictive, in this section, we entertain the possibility that tariffs respond to endogenous variables. Specifically, we now allow $\hat{\tau}_t$ to feed back from lagged values of all of the variables of the model, namely, output, the trade balance, the interest rate, inflation, and imports. Accordingly, we estimate the first-row elements of B_i for $i = 1, 2$, which were set to zero in the baseline estimation. Priors follow the same structure as in the baseline estimation: element $(1, 1)$ of B_1 has a normal prior with mean 0.95 and standard deviation 0.5, while all other first-row elements of B_1 and B_2 have normal priors with mean 0 and standard deviation 0.25.

Reestimating the model we find that jointly the tariff shocks z_t^τ and X_t^τ explain 84 percent of changes in tariffs, supporting the baseline assumption that these two shocks are the main drivers of τ_t. Also in line with the baseline specification, we find that the stationary tariff shock, z_t^τ is the main source of tariff fluctuations, accounting for 75 percent of the changes in τ_t explained by tariff shocks.

Figure 9 displays the impulse responses to a 10-percentage point increase in the transitory tariff shock z_t^τ in the model with endogenous tariffs. The results are quite robust to this modification, in the sense that the increase in tariffs continues to be noninflationary and noncontractionary. Further, as in the baseline specification with exogenous tariffs, the transitory tariff hike depresses imports and briefly improves the trade balance and induces the Fed to ease.

6.4 Adding Alternative Tariff Measures As Observables

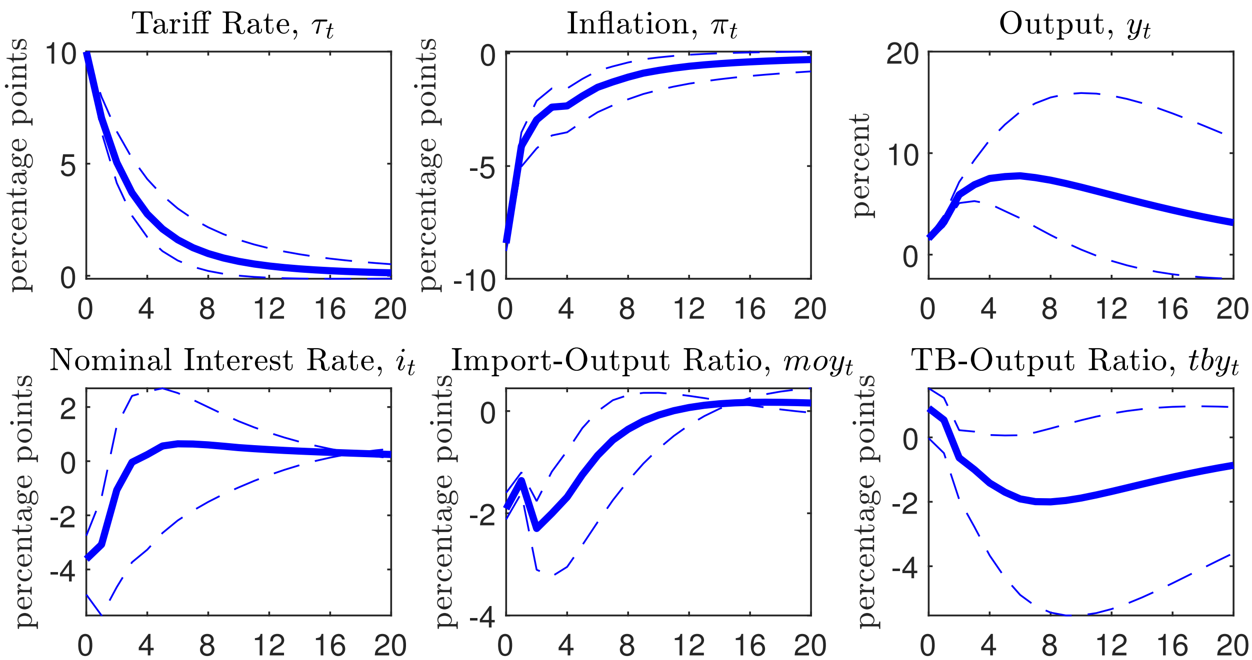
We now add the two alternative tariff measures introduced in section 2, the trade restrictiveness index (tri_t) and the fixed-weight import tariff (τ_t^F) as additional observables and reestimate the model.

We begin with tri_t. To this end, we assume that changes in τ_t and tri_t are linked by the relation

$$\Delta \mathrm{tri}_t^o = \Delta \tau_t + \mu_t^{tri}, \tag{28}$$

where μ_t^{tri} is assumed to be an exogenous i.i.d. normally distributed random variable. The rest of the model is as described in section 3.1. This formulation maintains that $\Delta \tau_t^o$ and $\Delta \mathrm{tri}_t^o$ are two alternative noisy measures of the unobserved change in the import tariff rate, $\Delta \tau_t$. Both time series contribute to the estimation of the parameters defining the laws of motion of the transitory and permanent tariff shocks. We impose a gamma prior distribution for the variance of μ_t^{tri} with mean equal to 25 percent of the sample variance of $\Delta \mathrm{tri}_t$ and standard deviation equal to 15 percent of the observed variance of $\Delta \mathrm{tri}_t$. The time series of tri_t starts in 1990:Q1, whereas the other observable time series included in the model start in

Figure 10: Impulse Responses to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^τ, with the TRI as Observable



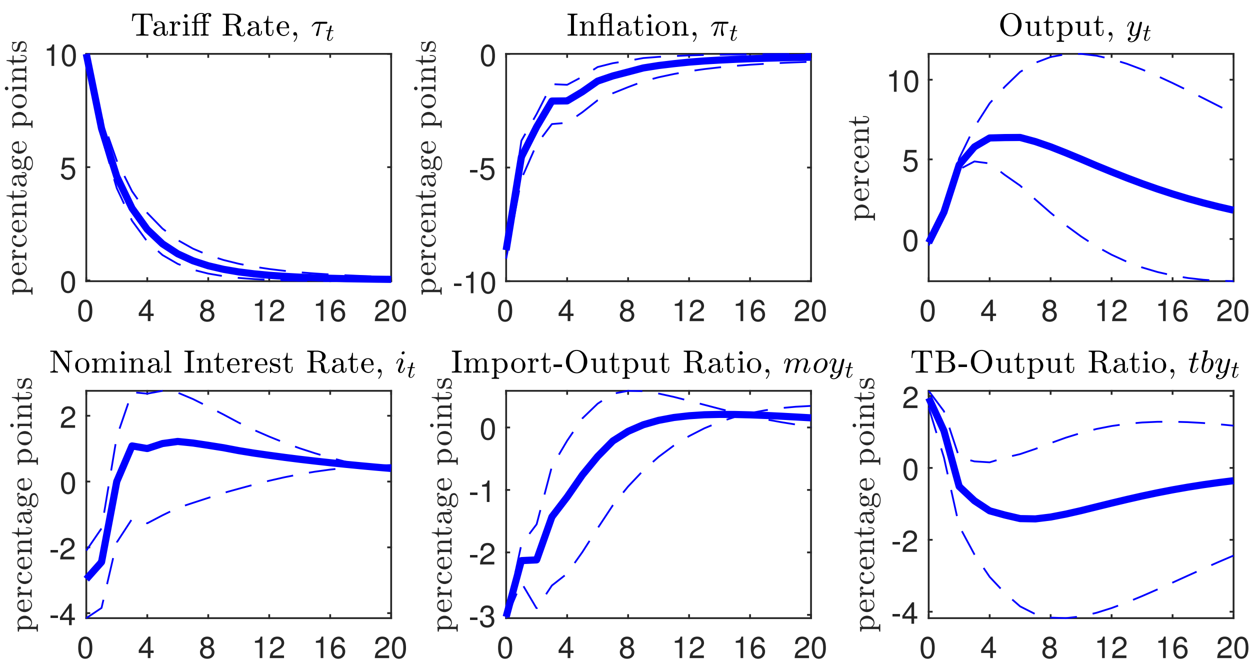
Notes. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are expressed in percent per year.

1959:Q1. Accordingly, we treat realizations of tri_t prior to 1990:Q1 as missing observations (Harvey, 1989).

Figure 10 displays impulse responses to a 10-percentage-point transitory increase in the import tariff rate. The dynamic response of the model is qualitatively similar to that of the model estimated without using information on the TRI. In particular, the transitory increase in tariffs is neither inflationary nor contractionary. Also, the transitory tariff increase induces a fall in the policy rate and the import-to-output ratio, and an improvement in the trade balance. A variance decomposition shows that under this specification the transitory component of the import tariff continues to explain the majority of movements in tariffs, with a share of 65 percent.

Next we reestimate the model using the fixed-weight import tariff, τ_t^F, as an additional observable. Specifically, we use the formulation in equation (28) replacing Δtri_t^o by $\Delta \tau_t^{Fo}$, where $\Delta \tau_t^{Fo}$ is the observed change in the fixed-weight import tariff rate. Figure 11 displays the impulse responses of the macroeconomic indicators of interest to a ten-percentage-point

Figure 11: Impulse Responses to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^τ, with the Fixed-Weight Tariff as Observable



Notes. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are expressed in percent per year.

transitory increase in the tariff rate (an increase in z_t^τ). The pattern that emerges is similar to that predicted by the baseline model and by the model estimated using the TRI as an additional observable. In particular, the transitory tariff hike is neither inflationary nor contractionary and not associated with a monetary tightening. Also, the temporary tariff increase lowers imports and improves the trade balance. Further, the estimated model also implies that transitory movements in tariffs are the major force driving variations in tariff rates over time, explaining 75 percent of changes in tariffs.

Taken together, the incorporation of the trade restrictiveness index or the fixed-weight tariff rate into the estimation suggests that a simple measure of the uniform tariff, such as the trade-weighted import tariff rate τ_t given in equation (1) and used in the baseline estimation of section 4, suffices to characterize the aggregate effects of innovations in import tariffs.

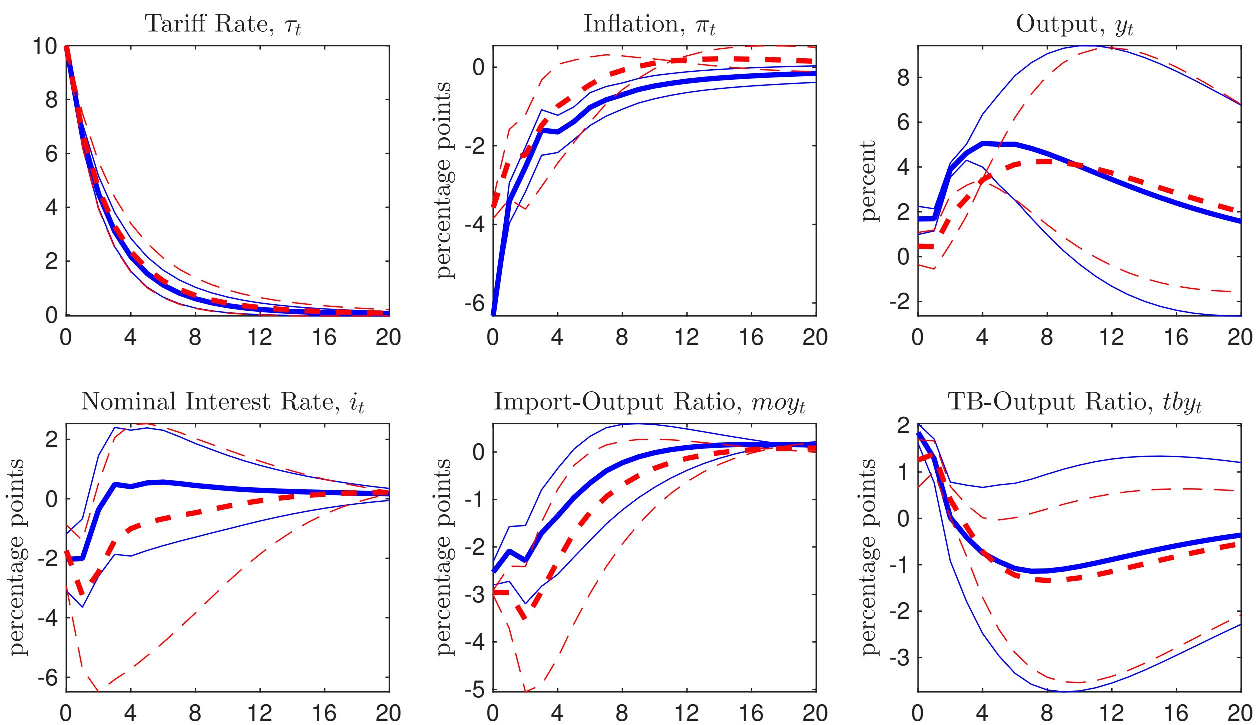
6.5 Nixon's Price Controls

A potential concern with the finding that transitory import tariff shocks are not inflationary is that this result may be driven by the Nixon price controls. The issue is that the estimated model interprets the Nixon tariff shock as a major temporary increase in tariffs. If inflation was artificially suppressed during that period because of the price controls, then the conclusion that transitory tariff increases are not inflationary could be contaminated. To address this issue, we reestimate the model eliminating the inflation observations for the duration of the Nixon price controls and treating them as missing observations.

The price controls were announced by President Nixon on August 15, 1971, as part of the "New Economic Policy," which also included the temporary import tariff surcharge. The initial phase consisted of a 90-day freeze on all wages, prices, and rents, with the exception of taxes, raw agricultural products, and mortgage interest. After this initial freeze, the controls evolved into a regime in which some prices and wages were allowed to adjust. The official end of the price controls was April 30, 1974. However, Blinder and Newton (1981) estimate that prices did not return to the level they would have reached absent controls until October of that year. Accordingly, we define the price-control period to be 1971:Q3 to 1974:Q3.

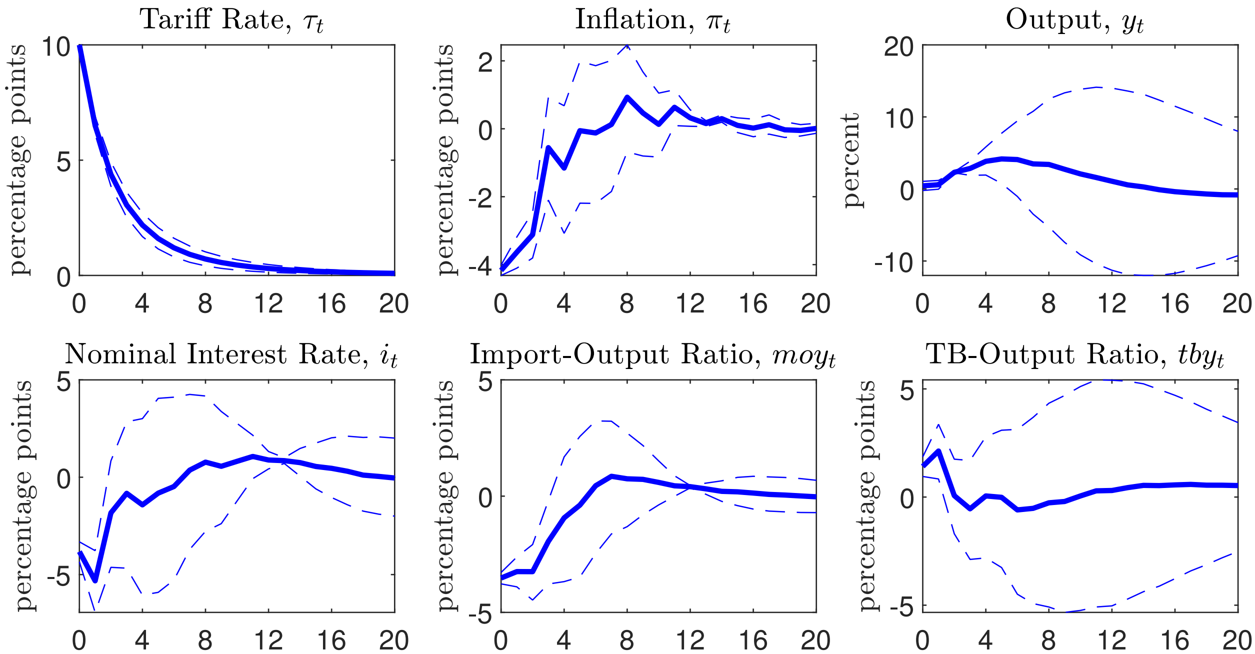
Figure 12 displays the impulse responses to a transitory tariff shock in the reestimated model alongside those implied by the baseline specification. The main finding is that the transitory tariff shock continues to be noninflationary. This result indicates that the baseline conclusion does not appear to be driven by the censoring of price growth during a major temporary tariff episode. The responses of the other endogenous variables are likewise similar across the two specifications. Further, neither the responses to a permanent tariff shock

Figure 12: Impulse Responses to a Temporary Increase in the Import Tariff: Excluding Nixon's Price Control



Notes. Horizontal axes measure quarters after the shock. Bold solid lines are posterior means and thin solid lines are 90-percent credible bands in the baseline model, reproduced from Figure 2. Bold dashed lines are posterior means and thin dashed lines are 90-percent credible bands when excluding observations on inflation during the Nixon price controls, 1971:Q3-1974:Q3. See also notes to Figure 2.

Figure 13: Impulse Responses to a Ten-Percentage-Point Increase in the Transitory Import Tariff Shock, z_t^τ, in a Model with Four Time Lags



Notes. Horizontal axes measure quarters after the shock. Solid lines are posterior means and dashed lines are 90-percent credible bands computed using the Sims-Zha (1999) method (principal component) from a random subsample of 100,000 posterior draws from an MCMC chain of 1,000,000 draws. Inflation and the nominal interest rate are in percent per year.

nor the variance decompositions, which we do not show in the interest of space, differ meaningfully from their baseline counterparts.

6.6 Four Lags

Figure 13 displays impulse responses to a 10-percentage point increase in the transitory tariff shock, z_t^τ, in an extension of the baseline model that includes 4 time lags instead of 2. As mentioned in section 4.1, this specification is substantially dominated by the 2-lag one in terms of its marginal data density (see Table B1 in Appendix B). It is apparent from the figure that the error bands are wider under this specification, which could be a reflection of the fact that adding lags does not significantly improve model fit. Nonetheless, the figure shows that the key results of the paper are robust to expanding the model to four lags. In particular, the increase in the import tariff is neither inflationary nor contractionary, the monetary authority responds by briefly easing, the import-to-output ratio falls, and the net-export-to-output ratio increases temporarily.

7 Conclusion

The use of tariffs in the United States has a long history. Surprisingly, there are few empirical studies devoted to uncovering their macroeconomic consequences. This paper contributes to this relatively thin literature. A key innovation of our approach is modeling tariffs as having a permanent and a transitory component and not assuming as part of the identification scheme that tariff increases have to be inflationary.

Both modeling innovations deliver important results. Transitory tariff increases are estimated to be deflationary, suggesting that they materialize through the demand channel. By contrast, permanent tariff increases are estimated to generate a short-lived increase in inflation. In line with the intertemporal approach to the balance of payments, temporary increases in tariffs tend to reduce imports and improve net exports, whereas permanent changes have insignificant effects on either variable. Tariff shocks have no discernible effect on U.S. competitiveness, as the real exchange rate response to transitory or permanent shocks is statistically insignificant.

Another key finding that emerges from the present analysis is that tariff shocks do not represent a quantitatively important source of business-cycle fluctuations. This result holds unconditionally, that is, over regular tariff movements, and also conditionally on episodes of large tariff shocks. However, this result should not be interpreted to mean that tariff shocks are macroeconomically costless. While their short-run aggregate effects are limited, they may still have meaningful consequences for long-run growth, income distribution, or the allocation of resources across sectors.

We explain the main empirical results through the lens of an optimizing open economy model that incorporates an import-competing sector. We show that this element of the model is important for understanding why output expands while absorption contracts following a transitory increase in import tariffs. Nonetheless, there remains scope for further research on the quantitative consequences of tariffs. In particular, it would be important to understand why their contribution to business-cycle fluctuations remains limited even during episodes of substantial tariff increases.

Appendix

A Data Sources

This appendix documents the sources and construction of the time series used in estimation.

All data are quarterly, spanning the period 1959:Q2 to 2024:Q4, except those used to construct the TRI, which span the period 1990:Q1 to 2024:Q4.

1. **Trade-Weighted Import Tariff Rate (τ_t):** Computed as the ratio of U.S. federal customs duties to U.S. imports of goods (excluding duties), following Irwin (2003). Specifically:

   (a) *Numerator:* U.S. federal import customs duties, from BEA NIPA Table 3.5U, line 15.

   (b) *Denominator:* Imports of goods, from BEA NIPA Table 1.1.5, line 20.

   The import tariff rate is calculated as:

$$\tau_t = 100 \times \frac{\text{Customs Duties}}{\text{Imports of Goods}}$$

2. **Real GDP per Capita (y_t):** Logarithm of U.S. real GDP per capita. Real GDP is sourced from BEA NIPA Table 1.1.6, line 1. Population is from BEA NIPA Table 2.1, line 40.

3. **Trade Balance to Output Ratio (tby_t) and the Import to Output Ratio (moy_t):** Ratio of net exports of goods and services to GDP and Ratio of imports of goods and services to GDP. Exports and imports are sourced from BEA NIPA Table 1.1.5:

   (a) Exports of Goods and Services: line 16.

   (b) Imports of Goods and Services: line 19.

   (c) Nominal GDP: line 1.

   The trade balance to output ratio is computed as exports minus imports of goods and services divided by nominal GDP and multiplied by 100. The import to output ratio is computed as imports of goods and services divided by nominal GDP and multiplied by 100.

4. **Federal Funds Rate (i_t):** Quarterly average of the effective federal funds rate. Source: Board of Governors of the Federal Reserve System, H.15 release, via FRED series `FEDFUNDS`. Monthly data were converted to quarterly averages and expressed in percent per year.

5. **Core CPI Inflation (π_t):** percent change in the Consumer Price Index (CPI) less food and energy. Source: U.S. Bureau of Labor Statistics, via FRED series `CPILFESL`. Monthly data were converted to quarterly geometric averages, from which quarter-over-quarter growth rates were computed and expressed in percent per year.

6. **Trade restrictiveness index $\mathbf{tri}_t$:**

   (a) Product-level imports, m_{it}, and import duties, d_{it}: United States International Trade Commission (2025).

   (b) Product-level import demand elasticities, ϵ_i: Kee, Nicita, and Olarreaga (2008), downloaded from World Bank Group (2025).

   (c) Product code concordances: United Nations (2025).

B Marginal Data Densities

Table B1 reports log marginal data densities (MDDs) for models with two and four lags ($L = 2$ and $L = 4$), computed using the modified harmonic mean estimator with a truncated chi-squared auxiliary density. It shows that the estimated MDDs are robust across a wide range of truncation parameters $p \in [0.1, 0.9]$, indicating numerical stability of the estimator. In all cases, the $L = 2$ model yields higher log MDDs than the $L = 4$ specification, suggesting that the data favor the more parsimonious model.

Table B1: Log Marginal Data Densities for the Baseline Model with Two and Four Lags

p	$L = 2$	$L = 4$
0.10	-1303.26	-1348.85
0.20	-1302.75	-1348.71
0.30	-1302.51	-1348.43
0.40	-1302.28	-1348.19
0.50	-1302.08	-1348.26
0.60	-1302.02	-1348.32
0.70	-1302.04	-1348.19
0.80	-1301.92	-1348.18
0.90	-1301.83	-1348.10

Notes. The variable p denotes the truncation parameter of the chi-squared auxiliary density, and L denotes the number of lags. The model specification is the one discussed in section 3.1.

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