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Tariffs, Employment and the Balance of Trade

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Abstract

The literature on tariffs is mostly static and focused on tariffs on consumer goods. We show that the macroeconomic consequences of tariff policies depend crucially on the type of goods over which tariffs are levied and on the time pattern of the tariffs. Under full employment, the trade-balance effect of tariffs depends critically on their time structure. With endogenous investment, tariff shocks may improve the trade balance but do so by crowding out investment. Tariffs on intermediate imports (typically about 50% of all imports) cause output and investment to fall and the trade balance to deteriorate. The objectives that trade-policy advocates typically list together — a smaller trade deficit and higher domestic investment — are mutually exclusive. When tariffs are levied under unemployment, we show that even the sign of the impact depends crucially on the root cause of unemployment.

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1 Introduction

Tariffs have been gradually lowered or even phased out over much of post-WWII history. This broadly supported move towards free trade took place through multilateral agreements developed over several negotiating rounds (under the auspices of GATT and its successor the WTO), through the formation of free trade blocks (the EU, NAFTA, Mercosur [1]). But that process of gradual reduction in trade barriers has come to an abrupt halt recently, with in particular the US slapping on huge tariffs on the exports of about every country in the world, with as stated objective to reduce the balance of trade deficit that the US runs with the rest of the world, boost domestic employment and, somewhat inconsistently given the intention to reduce trade deficits, boost domestic investment. Economists were quick to point out that trade deficits are macroeconomic phenomena driven by trends in savings and investment, and much less by movements in relative prices. We go beyond the existing literature by showing that the macroeconomic consequences of tariff policies also depend crucially on the type of goods over which tariffs are levied and on the time pattern of the tariffs.

An early point raised by trade economists is the observation by lerner (1936) that tariffs reduce imports but by drawing resources into the domestic economy equally reduce exports: Lerner symmetry states that import tariffs are equivalent to export taxes [2]. Notwithstanding these examples, the literature on the intertemporal impact of interventions in international trade is thin, classical Trade theory is mostly set in a static environment. lerner (1936) is also set up in a static model. But the trade balance is a quintessentially intertemporal concept. A compelling analysis of the relation between trade policy, the time pattern of tariffs and the balance of trade requires an explicitly intertemporal setting.

Razin and Svensson (1983) and van Wijnbergen (1987) do provide an early analysis of the impact of trade policy on the trade balance in such an explicitly intertemporal setting, but have another limitation: Both deal with tariffs on final goods only. But intermediate and capital goods make up by far the largest part of internationally traded goods: a typical country's imports consist for some 50% of intermediate goods, with the other 50% roughly equally made up by capital goods imports and consumer goods. So most of the literature on the trade balance impact of tariffs applies to some 25% of international trade flows at most.

In this paper we address both shortcomings by introducing trade in intermediate, capital and final goods, and in an explicitly intertemporal setting. The paper is organized as follows. In Section 2 we review the relevant literature. In Section 3 we set up and use the equilibrium version of our model. Section 3.1 presents the structure of the equilibrium model. We use that model version to analyse tariffs on consumption goods in Section (3.2). We add tariffs on imported capital goods in Section (3.3) and on intermediate imports in 3.4. In section 4 we analyze the impact of tariffs under unemployment, where we follow Lorenzoni and Werning (2024) in distinguishing classical supply shock related unemployment and Keynesian unemployment induced by a shortfall of aggregate demand. In section 4.1 we assume that real wage resistance (indexation of wages on the consumption price index) is the root cause of unemployment. Section 4.2 analyzes the impact of tariff policy in a regime of Keynesian unemployment where rigid prices and an overvalued exchange rate trigger unemployment. Section 5 summarizes

[1] There is some dispute in the literature whether FTAs really promote the move towards less distorted trade: doubtlessly so for intra-block trade but trade diversion from trading partners outside the block may be a spoiler.

[2] See Costinot and Werning (2019) for a modern treatment, and Razin and Svensson (1983), who point out that the equivalence breaks down for temporary trade taxes.

and concludes.

2 Literature Review

Recent policies in the US indicate that politicians continue to believe that tariffs improve the trade balance, but economists have early on voiced doubts. Lerner (lerner (1936)) pointed out that tariffs and export taxes have similar effects: the first order impact of both import tariffs and export taxes is to reduce imports AND exports. In later years, the emergence of the intertemporal approach to the Trade Balance and Current Account strengthened those doubts: to lead to an improving trade balance, tariffs had to somehow increase aggregate savings or reduce aggregate investment. Razin and Svensson (1983) show that in an explicitly intertemporal (two period) setting, Lerner symmetry holds: permanent import tariffs have the same effect on imports and exports; trade balance effects may nevertheless occur if pre-tariff import shares in consumption change over time and Razin and Svensson (1983) provide an early intertemporal analysis, confirming Lerner Symmetry for permanent tariffs but symmetry breaks down for temporary trade taxes. More recently Furceri et al. (2022),in a wide ranging study covering 151 countries and decades of time, provide empirical evidence on the impact of tariffs on the trade balance: using a Local Projections approach, the IRFs their results suggest all kind of macro-effects but a negligible trade balance response.

The traditional static analysis of tariff changes typically focuses on economic efficiency, on the impact of tariffs on the terms of trade, the related concept of optimal tariffs and the consequences of retaliatory tariffs (i.e. trade wars)[3]. All this is by now standard textbook material (cf for example Dixit and Norman (1980)). Costinot and Werning (2019) gives a wide ranging review of second best arguments for trade intervention in Pigouvian approach, mostly focusing on various distributional arguments.

In this paper we sidestep the allocative efficiency issues central to the classical trade theory literature by adopting a Mundel-Fleming complete specialization approach, to better focus on intertemporal issues and employment. In this we follow van Wijnbergen (1987), who also argues that tariffs only improve the trade balance if they change intertemporal relative prices.

A difficulty in applying these insights from the literature to the current debate on tariffs is that the literature focuses almost exclusively on trade in final consumption goods. But in most countries (including the US), import flows consist for about 50% of intermediate imports, consumption goods make up at most some 25% of total imports, while the remainder consists of capital goods imports (see World Bank (2026) for data on trade flows and their composition). An exception is Lorenzoni et al. (2025): they analyze the macroeconomic impact of imposing tariffs on intermediate imports but focus on the optimal monetary policy response and sidestep intertemporal issues by assuming balanced trade.

More recently the tariff policies of the first and second Trump administration in the US have triggered new research in two area's: first the question of who actually bears the tariff burden, i.e. the question of tariff incidence. Generally, the tariffs recently imposed by the US seem to have been shifted forward: exporters largely

[3]Itshkoki and Mukhin (2025) consider optimal tariffs and retaliation, but also in an essentially static analysis. Trade imbalances do not arise from intertemporal consumer choice but exist as a match to long run surpluses on the capital account

left their prices unchanged thereby shifting the burden to either intermediate importers or to final consumers (see Cavallo et al. (2019), Gopinath and B.Neiman (2026) or Ossa (2026), all of whom find almost 100% forward shifting of the recent spate of US tariffs.[4].

There is a second group of more recent papers that focuses on the macroeconomic impact of tariff changes and thus comes closer to our analysis. This part of the literature is not empirical nor theoretical but uses calibrated quantitative models, embedding tariffs in relatively standard Neo-Keynesian macro-models. Some authors use the Small Open Economy (SOE) assumption we also use (i.e. foreign prices are taken as given, cf Monacelli (2025)) while others in this group formulate a two-country model to analyse retaliatory tariffs and tariff wars (see for example Auclert et al. (2025), who consider the impact of permanent tariffs under Keynesian unemployment, like we do in section 4. They do not look at other types of unemployment nor do they consider temporary tariffs. They find that permanent tariffs may in fact improve the trade balance under Keynesian unemployment, a result that was to be expected as we show in our theoretical analysis. Bergin and Corsetti (2025) focuses on the optimal monetary policy response to sectoral tariffs. In all these papers the main emphasis is on interaction with monetary policy, a subject we do not discuss. Costinot and Werning (2025) also do not address monetary policy, focusing on the relation between non-homotheticity of preferences and the trade balance impact of permanent tariffs. None of the papers highlights the differential effect of imposing tariffs on imports of final versus intermediate or capital goods, a key feature of the current paper.

3 Tariffs and the Balance of Trade when wages and prices clear markets

We analyze the impact of tariffs using duality theory[5], since prices and welfare are our key variables and those are at center stage in the dual approach. We do not want to focus on allocative efficiency since that problem is analyzed extensively in the traditional static theory of international trade (cf again Dixit and Norman (1980) for a particularly lucid exposition); therefore we adopt a model in the Mundel-Fleming complete specialization tradition: we distinguish two final goods, only one of which is produced at home. The intermediate input into production is imported; allowing for domestic production of the intermediate good would add complexity but no additional insights.

We use a simple two-period structure to capture intertemporal price effects. As explained in the introduction, we abstract from monetary policy issues. We analyze two versions of the model: in this Section the equilibrium model of Section 3.1 is used. By assumption all prices move to clear all corresponding markets in both periods. In the disequilibrium model used in Section 4 we first assume that real wage indexation on consumer prices prevent first period full employment (cf Section 4.1 while second period wages are flexible and clear the second period labor market. In section 4.2 we assume Keynesian unemployment: home goods prices are contractually fixed in the first period ("the short term") at a level too high for commodity market clearing while they are flexible in

[4]Flaaen et al. (2025) even document an occasion of over-shifting: in the market for French wines consumer prices and total consumer costs went up by more than the trump administration collected in tariff revenue...

[5]see Dixit and Norman (1980) for a detailed presentation of traditional trade theory using duality.

the second period ("the long term").

3.1 The Equilibrium model

There are two periods: upper case letters indicate first period variables and lower case letters second period variables. First output X is limited by productive capacity, which depends on three factors of production: capital K, labour L and intermediate input Z which for simplicity's sake we assume is not produced domestically. Z thus constitutes the volume of intermediate imports. Capital K is inherited from the previous period and thus exogenous in the first period but endogenous in the second period. In the equilibrium version used in this Section, wages adjust so labor demand L equals total labor supply $\bar{L}$ which we set equal to 1. Following the duality approach used extensively in for example Dixit and Norman (1980) we define a revenue (or value added) function R:

$$R = max[PX - QZ]\, subject\, to\, X \leq F(K, L, Z) \tag{1}$$

$$= R(P, Q; K, \bar{L}). \tag{2}$$

with partial derivatives:

$$X = \frac{\partial R}{\partial P} = R_P \tag{3}$$

$$Z = -\frac{\partial R}{\partial Q} = -R_Q \tag{4}$$

$$W = \frac{\partial R}{\partial L} = R_L \tag{5}$$

P is the price of the domestic product in period 1 in terms of the foreign good in period 1 and p the home goods price in period 2. Foreign goods are assumed fixed over time (because of the SOE assumption) and are the numeraire commodity, so P and p represent the tariff- exclusive final goods terms of trade in respectively period 1 and period 2. The second period revenue function $r = r(p, q; k, \bar{l})$ is defined in the same way as R. $\bar{l}$ always equals 1 so the argument is suppressed in what follows. $t_{c,1}, t_{c,2}$ are the first and second period tariffs on consumer goods imports. We consider tariffs on intermediate goods separately from tariffs on final goods. $t_{int,1}$ are the tariffs on intermediate goods in the first period and $t_{int,2}$ the tariffs on intermediate imports in the second period. Q is the tariff-inclusive price of intermediate imports while Q^* is the tariff-exclusive price, both in period 1. And q, q^* are the corresponding prices in the second period:

$$Q = Q^*(1 + t_{int,1}),\ q = q * (1 + t_{Iint,2}) \tag{6}$$

W is the first period wage rate, and labor demand in period 1 follows from:

$$\frac{\partial R(P, Q; K, L)}{\partial L} = W \tag{7}$$

which implies the labor demand function

$$L = L(\underset{-}{W}, \underset{+}{P}, \underset{-}{Q}; K) \tag{8}$$

The partial derivative with respect to Q is negative under the usual assumption of technological complementarity between labor and intermediate inputs (for example energy or oil). In this section we assume labor market clearing. In Section 4 we introduce labor market disequilibrium and unemployment.

Firms, by choosing the first period level of investment I, set the second period capital stock $k = K + I$ in such a way that the discounted marginal revenue of an additional unit of capital tomorrow equals the production costs today[6]:

$$\delta^* \frac{\partial r}{\partial k} = P \tag{9}$$

ρ^* is the foreign goods real interest rate and δ^* the corresponding discount factor. Solving Equation 9 for k^* gives us $k^* = k^*(P, p, q, \delta^*)$ with the following partial derivatives:

$$\frac{\partial k^*}{\partial P} = \frac{1}{\delta^* r_{k,k}} < 0 \qquad \frac{\partial k^*}{\partial \delta^*} = -\frac{r_k}{r_{k,k}} > 0 \tag{10}$$

$$\frac{\partial k^*}{\partial p} = -r_{k,p} r_{k,k}^{-1} > 0 \qquad \frac{\partial k^*}{\partial q} = -r_{k,q} r_{k,k}^{-1} < 0 \tag{11}$$

$$\tag{12}$$

The signs reflect declining marginal productivity of capital ($r_{k,k} < 0$) and the assumption that the cross derivative between capital and intermediate inputs ("energy") is positive: by assumption, more use of the intermediate good in production raises the marginal productivity of capital .

Consider next the consumption side of the model. We define tariff-inclusive and tariff-exclusive prices for the final good import the same way we set up tariff in/exclusive prices for the intermediate import, with $t_{c,1}, t_{c,2}$ first and second period final goods import tariffs respectively. The first (second) period tariff-exclusive price of the foreign final good $P^* = 1$ ($p^* = 1$) by choice of numeraire and the use of the SOE assumption. The *first period* tariff-exclusive price of the *second period* imported final good equals δ^*. So we get for the tariff-inclusive prices of the current and future foreign good:

$$P_f = (1 + t_{c,1}) \tag{13}$$

$$p_f = (1 + t_{c,2}) \tag{14}$$

Next we define the price of the first period aggregate good consisting of the domestic and foreign good as Π. The (undiscounted) **period 2** price of the second period aggregate good equals π while the (discounted) **period 1** price of the second period aggregate final good equals $\delta^* \pi$. We assume preferences are homothetic and separable

[6] In this section we assume that capital goods are produced from home goods only; we explore the consequences of using intermediate imports in the production of capital goods in section 3.3.

over time, which implies that the period-by-period price indices of aggregate consumption do not depend on the level of consumption expenditure in the corresponding period: $\Pi = \Pi(P, 1 + t_{c,1})$ and $\pi = \pi(p, 1 + t_{c,2})$.

Homotheticity and separability over time are represented by an homothetically separable utility function U. Homotheticity implies that the aggregate price indices Π and π depend on concurrent prices only and in particular not on expenditure levels. We define an expenditure function E, consistent with such a utility function, where E represents the minimum discounted level of expenditure necessary to reach welfare level U:

$$E = E(\Pi(P, 1 + t_{c,1}), \delta^* \pi(p, 1 + t_{c,2}); U) \tag{15}$$

By property of expenditure functions (see Dixit and Norman (1980)) the derivative of E with respect to a particular price is equal to the demand for the corresponding good given U and prices: $E_P = C$ etcetera. Because of homothetiticty and separability we get that the aggregate price functions Π and π themselves are also (unit) expenditure functions.

The impact of income effects of tariffs is trivial so we eliminate them from our analysis by assuming that tariff revenues are redistributed. Consumers have to satisfy their intertemporal budget constraint (ITBC): the expenditure necessary to achieve utility U equals the revenue from production today plus discounted income from production tomorrow minus investment expenditure. The handing out assumption implies that tariff revenues drop out of the definition of the ITBC:

$$ITBC: \ E = R + \delta^* r - PI \tag{16}$$

The model is completed by commodity and labor market clearing conditions:

$$R_P = E_P + E_P^* + I \tag{17a}$$

$$r_p = E_p + E_p^* \tag{17b}$$

$$R_W = \tilde{L} \tag{17c}$$

The small country assumption implies that tariffs are completely shifted forward, in the case of tariffs on imported consumer goods to domestic consumers. [7] Also in line with the small country assumption, we assume the pre-tariff price of second period foreign goods in terms of first period foreign goods, $\delta^* = \frac{1}{\rho^*}$, is fixed,they are assumed to be a Hicks aggregate and their market clearing equation drops out via Walras' law.

The analysis proceeds in steps. We first analyse, in Subsection 3.2, the impact that tariffs on final goods imports have on the trade balance in a full employment version of the model, simplified by assuming exogenous investment and the absence of intermediate imports, to establish a benchmark result. This simplified benchmark equilibrium version of the model is presented in Section 3.2. Investment is endogenized in Section 3.3 where we also consider tariffs on imported capital goods. Imported intermediate goods and tariffs on imported intermediate goods are introduced in Section 3.4. In Section 4) we introduce disequilibrium: in Section 4.1 we assume that real

[7] Although classifying the USA as a small country may be a bit of a stretch of imagination, forward shifting seems to have been the case with the tariffs imposed by the Trump administration during 2018-2019 and again in 2025, (Cavallo et al. (2019) or Gopinath and B.Neiman (2026)).

consumption wages are contracted before tariffs are introduced so as to analyze the potential impact of tariffs on real wage resistance induced unemployment. In Section 4.2 we introduce lack of effective demand and an overvalued exchange rate to analyze the impact of tariffs under Keynesian unemployment.

3.2 Tariffs on imported Consumption Goods: the benchmark case

In this section we consider final goods imports only, full employment in both periods and no investment nor intermediate goods. These assumptions imply $R_{P,P} = r_{p,p} = 0$. We consider the impact of raising tariffs around a zero tariff starting point. Differentiating the ITBC consumers face gives the link between changes in consumer tariffs, the terms of trade and utility for both domestics (dU) and foreigners (dU^*). Consider first the welfare impact of terms of trade changes dP, dp:

$$E_U dU = ((R_P - E_P)dP + (r_p - E_p)\delta^* dp \tag{18a}$$

$$= E_P^* dP + E_p^* \delta^* dp \tag{18b}$$

$$E_{U^*}^* dU^* = -E_P^* dP - E_p^* \delta^* dp \tag{18c}$$

Next differentiate the commodity market clearing equations 17a and 17b, and use $R_{P,P} = r_{p,p} = 0$, to get:

$$-\Sigma_{P,P} dP - \Sigma_{P,p} dp = E_{P,f_1} dt_1 + E_{P,f_2} dt_2 \tag{19a}$$

$$-\Sigma_{p,P} dP - \Sigma_{p,p} dp = E_{p,f_1} dt_1 + E_{p,f_2} dt_2 \tag{19b}$$

$\Sigma_{i,j}$ is the world substitution matrix plus income effects of terms of trade changes; for example:

$$\Sigma_{P,P} = (E_{PP} + E_{PP}^* + (mc_P - mc_P^*)E_P^*) \tag{20a}$$

$$< 0 \tag{20b}$$

assuming the marginal spending coëfficients mc_P and mc_p^* are sufficiently close. Note that $E_{P,P}, E_{p,p} < 0$ and $E_{P,p}, E_{p,P} > 0$. The same holds for the foreign equivalents $E_{P,P}^*$ etc. And since output is exogenous in this version of the model, $R_{P,P} = 0$.

Solving the set of equations (19a(and (19b) leads to expressions for the terms of trade impact of tariff changes. Consider first the impact of first and second period tariffs on the first period terms of trade P:

$$\frac{dP}{dt_1} = \frac{\Sigma_{P,p} E_{p,f_1} - \Sigma_{pp} E_{P,f_1}}{\Delta} > 0 \tag{21a}$$

$$\frac{dP}{\delta^* dt_2} = \frac{\Sigma_{P,p} E_{p,f_2} - \Sigma_{p,p} E_{P,f_2}}{\Delta} > 0 \tag{21b}$$

In the same way we find the impact of first and second period tariff changes on the real exchange rate tomorrow:

$$\frac{dp}{dt_1} = \frac{\Sigma_{p,P}E_{P,f_1} - \Sigma_{P,P}E_{pf_1}}{\Delta} > 0 \tag{22a}$$

$$\frac{dp}{\delta^* dt_2} = \frac{\Sigma_{p,P}E_{P,f_2} - \Sigma_{P,P}E_{pf_2}}{\Delta} > 0 \tag{22b}$$

Since E is an expenditure function, the cross derivatives give pure substitution effects so $E_{i,i} < 0$, and $E_{i,j} > 0$ for $i \neq j$, from which the inequalities in 21a and 22a follow. A tariff on first period imports switches demand towards current and through cross-period elasticities to future home goods, so the real exchange rate appreciates in both periods. Second period tariffs also lead to demand switching towards both second and first period home goods so second period tariffs also lead to a real appreciation in both periods.

Finally consider the impact of permanent tariffs $d\tilde{t}$ with $dt_1 = dt_2 = d\tilde{t}$. First define $\frac{dP}{d\tilde{t}} \equiv \frac{dP}{dt_1} + \frac{dP}{\delta^* dt_2}$ and similarly $\frac{dp}{d\tilde{t}} \equiv \frac{dp}{dt_1} + \frac{dp}{\delta^* dt_2}$.

Now define $\delta_c = \frac{\delta^* \pi}{\Pi}$ as the consumption discount factor (the inverse of one plus the Consumption Rate of Interest): δ_c equals the relative price of aggregate expenditure tomorrow over the price of aggregate expenditure today. It is straightforward to show that a permanent tariff $d\tilde{t}$ has no impact on the consumption discount factor $\delta_c = \frac{\delta^* \pi}{\Pi}$:

$$\frac{dP}{\tilde{dt}} = \frac{\Sigma_{p,P}(E_{p,f_1} + E_{p,f_2}) - \Sigma_{p,p}(E_{Pf_1} + E_{P,f_2})}{\Delta} \tag{23a}$$

$$\frac{dp}{d\tilde{t}} = \frac{\Sigma_{p,P}(E_{P,f_1} + E_{P,f_2}) - \Sigma_{P,P}(E_{pf_1} + E_{p,f_2})}{\Delta} \tag{23b}$$

$$=> \frac{\delta_c}{d\tilde{t}} \propto (\frac{\delta^* dp}{d\tilde{t}} - \frac{dP}{d\tilde{t}}) = 0 \tag{23c}$$

A permanent tariff $d\tilde{t} > 0$ does not affect the consumption discount factor.

Consider next the trade balance [8]. First period real expenditure E_Π homogenous of degree zero since E is homogenous of degree 1, so E_Π, real expenditure in period 1, depends on U and the consumption discount factor δ_c only:

$$E_\Pi = E_\Pi(1, \delta_c; U) \tag{24}$$

Consider now the first period trade balance of the home country, TB_1:

$$TB_1 = R + t_1 E_{f_1} - \Pi E_\Pi \tag{25}$$

The budget constraints facing home country residents under our assumption of tariff revenues being handed out (randomly) within the period they are collected then imposes:

$$TB_1 + \delta^* TB_2 = 0$$

which is equivalent to equation 16.

[8] Since there is no initial debt and therefore no interest payments, the trade balance and the current account coincide.

Tariffs appear in the TB equation as government revenue and as an expense item in private expenditure[9] and we differentiate around zero initial tariffs; so there is no direct income effect of the tariffs themselves as long as the tariffs are completely shifted forward and the revenues handed out, which is what we have assumed throughout.

Consider now the impact of a temporary tariff, $dt_1 > 0, dt_2 = 0$, on the period 1 trade balance:

$$\frac{dTB_1}{dt_1} = \frac{\partial TB_1}{\partial dP}\Big|_{\delta_c=\overline{\delta_c}} \frac{dP}{dt_1} + \frac{\partial TB_1}{\partial dp}\Big|_{\delta_c=\overline{\delta_c}} \frac{dp}{dt_1} + \frac{\partial TB_1}{\partial \delta_c}\frac{d\delta_c}{dt_1} \tag{26}$$

$$= \underbrace{E_P^*(1 - C_{1E})\frac{dP}{dt_1}}_{\text{A}} - \underbrace{E_p^* C_{1E}\frac{dp}{dt_1}}_{\text{B}} - \underbrace{\Pi E_{\Pi.\pi}\frac{d\delta_c}{dt_1}}_{\text{C}} \tag{27}$$

(A) is the part of today's income gain due to a real appreciation dP today that is spent tomorrow and (B) is the part of tomorrow's income gain due to tomorrow's real appreciation dp that is spent today. The two cancel under reasonable symmetry conditions[10] if the real appreciation today equals the real appreciation tomorrow. Under the same pre-tariff-shock symmetry conditions between period 1 and period 2 (cf van Wijnbergen (1987) for an elaboration), we can say more generally:

$$(A) \gtreqless (B)\ if\ \frac{dP}{dt_1} \gtreqless \frac{dp}{dt_1} \tag{28}$$

Also, if $\frac{dP}{dt_1} \gtreqless \frac{dp}{dt_1}$, we get $\frac{d\delta_c}{dt_1} \gtreqless 0$ so $-(C) \gtreqless 0$ too [11]. We thus get an unambiguous result for the trade balance effect of temporary tariffs ($dt_1 > 0, dt_2 = 0$):

$$\frac{dTB_1}{dt_1} \propto (\frac{dP}{dt_1} - \frac{dp}{dt_1}) \tag{29}$$

Remains to answer the question of whether the real appreciation today is larger or smaller than the real appreciation tomorrow after a temporary tariff increase dt_1. Combining Equations 21 and 22 gives the answer:

$$\frac{dP}{dt_1} - \frac{dp}{dt_1} \propto \frac{(E_{P,f_1} - E_{p,f_1})}{\Delta} > 0 \tag{30}$$

So if foreign goods today and home goods today are closer substitutes than foreign goods today are for home goods tomorrow (i.e. $\frac{E_{P,f_1}}{E_P} > \frac{E_{p,f_1}}{E_p}$), which is a reasonable assumption we will make,we get a larger shift towards home goods today than to home goods tomorrow after an increase in first period tariffs. As a consequence the real exchange rate appreciates more today than it appreciates tomorrow and the consumer discount factor δ_c therefore goes down (consumption rate of interest goes up). As a consequence a trade surplus results in response to a temporary tariff increase if the cross-elasticity condition of equation 31 is satisfied. :

$$\frac{E_{P,f_1}}{E_P} > \frac{E_{p,f_1}}{E_p} => \frac{dTB_1}{dt_1} > o \tag{31}$$

[9] note that tariffs are embedded in the unit expenditure functions Π and π

[10] If the two periods are not of equal length a trivial correction factor T_1/T_2 is needed. Without loss of generality we assume equal length to avoid having to carry this correction term along everywhere.

[11] $E_{\Pi,\pi} > 0$ by properties of expenditure functions.

In the same way we can use equation 22 and show that, under the symmetric assumption that foreign good tomorrow are closer substitutes to home goods tomorrow than they are to home goods today, future tariffs, $dt_1 = 0, dt_2 > 0$ lead to a larger appreciation tomorrow than today:

$$\frac{dP}{dt_2} - \frac{dp}{dt_2} \propto \frac{E_{Pf_2} - E_{pf_2}}{\Delta} < 0 \tag{32}$$

So an anticipated tariff tomorrow ($dt_1 = 0, dt_2 > 0$) has the opposite effect of a temporary tariff today: a smaller real appreciation today than tomorrow and a trade deficit today.

A final result follows almost directly for a permanent tariff. Under the symmetry assumptions made, 21 and 22 imply that a permanent tariff leads to the same real appreciation today as tomorrow, as shown in Equation (49c), and thus leaves the consumption discount factor unchanged. As a a result permanent tariffs do not lead to a change in the trade balance:

$$if\ dt_1 = dt_2 > 0 => \frac{dTB_1}{d\bar{t}} \equiv \frac{dTB_1}{dt_1} + \frac{TB_1}{dt_2} = 0 \tag{33}$$

When the same tariff is introduced in both periods ($dt_1 = dt_2 > 0$), the two effects cancel and the overall TB response to a permanent tariff is zero.

3.3 Endogenous investment and tariffs on imported capital goods

Consider now the results when first period investment is endogenized and subject to a tariff t_I. The input cost of capital goods then becomes $\Phi_I(P, 1 + t_I)$ [12].:

$$d\Phi = \phi dP + (1 - \phi)dt_I \tag{34}$$

Endogenizing investment requires only minor extensions to the exogenous capital variant of the model used in Section 3.2. First period output is still exogenous, but now there is an additional demand component in the first period, capital investment I. And I changes second period capital, so period 2 output becomes endogenous.

It helps to go through the solution in steps. Label the solution for exogenous investment ($dk^* = 0$): $\frac{dP}{dt_1}|_C$. We follow the same notational convention for the other variables. The modified model equations then become:

$$R_P = E_P + E_P^*[+\phi I] \tag{35a}$$

$$r_p(..|K[+I]) = E_p + E_p^* \tag{35b}$$

$$[\delta^* r_k][= \Phi] \tag{35c}$$

$$E = R[-\Phi I] + \delta^* r(...|K[+I]) \tag{35d}$$

with an additional equation defining the optimal period-2 capital stock: equation 35c. Investment now explicitly appears in the first period commodity market clearing equation 35a, in the second period commodity

[12] In period 2 there are no imported capital goods so there is no need to add a time index to t_I.

market clearing equation through its impact on the capital stock in that period and in the Intertemporal Budget Constraint equation 35d. Differentiating the ITBC leads to the same welfare effects of real exchange rate changes as in the previous section: dI, changes in investment, have no direct welfare effect through what comes down to an envelope theorem if we assume investment is set at its optimum, i.e. $\delta^* r_K = \Phi$.

We use equation 35c to derive I as a function of all prices:

$$\frac{dI}{dP} = \frac{d\Phi}{dP}\frac{1}{\delta^* r_{kk}} = \frac{\phi}{\delta^* r_{kk}} \qquad < 0 \tag{36a}$$

$$\frac{dI}{dp} = -\frac{-r_{kp}}{r_{kk}} \qquad > 0 \tag{36b}$$

$$\frac{dI}{dt_I} = \frac{d\Phi}{dt_I}\frac{1}{\delta^* r_{kk}} = \frac{(1-\phi)}{\delta^* r_{kk}} \qquad < 0 \tag{36c}$$

$$\frac{dI}{d\delta^*} = \frac{-r_k}{\delta^* r_{kk}} \qquad > 0 \tag{36d}$$

A higher first period real exchange rate P lowers investment as it at least partially raises investment costs: home goods are a fraction ϕ of total input costs Φ. But a higher second period real exchange rate p raises the value of the additional output more investment leads to, so a higher p has a positive impact on I. And first period tariffs have a direct negative impact on investment to the extent investment uses imports as input: they make up a fraction $(1-\phi)$ of total unit investment costs Φ so $\frac{dI}{dt_I} < 0$ if $\phi < 1$.

Before discussing the more general solution consider first the special case where investment is made up of domestic goods only: $\phi = 1$, i.e. when investment consists of domestic products only, an assumption that is not so far off for most countries because of the importance of construction in investment expenditure[13]. The case of $\phi = 1$ allows for a particularly simple solution. Note that $r \equiv px$ and x is homogenous of degree zero since r is homogenous of degree one. It therefore immediately follows from equation 35c that investment I is a function of the investment discount factor $\delta_I \equiv \frac{\delta^* p}{\Phi}$ only.

The results of our benchmark case with permanent tariffs on consumption good imports immediately carry over to the endogenous investment case when investment uses domestic input only: for given investment a permanent tariff has the same impact on tariffs today as it has on tariffs tomorrow, with no impact on the intertemporal terms of trade, whether for consumption or for investment: δ_I does not change. And since for $\Phi = P$ we get that I depends on δ_I only, we get for the endogenous investment case with investment consisting of home goods only ($phi = 1 => \Phi = P$) that after a permanent increase in tariffs on consumer goods $d\tilde{t}$ the following holds:

$$if\ \Phi = P => \frac{d\delta_I}{d\tilde{t}} = 0 \tag{37}$$

$$=> \frac{TB_1}{d\tilde{t}} = 0 \tag{38}$$

[13]In the US for example aggregate investment is typically around 18 % of GDP and imports about 14% of GDP, of which 30% are capital goods, so foreign goods make up 27% of aggregate investment. Source: U.S. Census Bureau and U.S. Bureau of Economic Analysis (2025), Bureau/BEA 2024 data

But temporary tariffs (on consumer goods, there are no period 2 tariffs on investment goods since there is no investment in period 2) again changes produce different results compared to what happens when tariffs are permanent, also when investment is endogenized. We already saw that for given investment we get that today's real appreciation exceeds tomorrow's real appreciation after a temporary tariff increase, which in itself does lead to an improvement in the balance of trade since current home goods go up in price more than future home goods. But a larger appreciation today than tomorrow also reduces the return on investment δ_I). which triggers a fall in investment. This leads to a further improvement in the Balance of Trade because in addition to the shift of consumer expenditure from today to tomorrow (increase in first period savings) we now also get a fall in investment, both of which lead to an improvement in the Trade Balance:

$$if\ \Phi = P => \frac{d\delta_I}{dt_1}, \frac{d\delta_c}{dt_1} < 0 \tag{39}$$

$$=> \frac{dI}{dt_1} < 0\ and\ \frac{d(E_{\Pi}\Pi)}{dt_1} < 0 \tag{40}$$

$$=> \frac{dTB_1}{dt_1}|_{C+I} > \frac{dTB_I}{dt_1}|_C > 0 \tag{41}$$

So with endogenous investment temporary tariffs on consumer goods imports lead to a higher trade surplus than we get in a world with consumption goods only, because the fall in investment increases the trade surplus further compared with the permanent tariffs case and because savings increase in response to the intertemporal relative price shift in consumption prices the fall in investment also triggers: $\frac{d\delta_c}{dt_1}|_{C+I} < 0$ also.

It is straightforward to show that for an anticipated future tariff increase ($dt_2 > 0$) we get similar results although opposite in sign::

$$if\ \Phi = P => \frac{d\delta_I}{dt_2} > 0 \tag{42}$$

$$=> \frac{dI}{dt_2} > 0 \tag{43}$$

$$=> \frac{TB_1}{dt_2}|_{C+I} < \frac{TB_1}{dt_2}|_C < 0 \tag{44}$$

An anticipated future tariff increase ($dt_1 = 0, dt_2 > 0$) lead to an anticipated future real appreciation and therefore to an investment boom instead of a fall (cf equation 36), but also to a deterioration of the trade balance even for given investment, a deterioration which is reinforced by the investment boom. **So unfortunately, claiming both an investment boom and an improvement in the trade balance is not going to work, the trade balance and investment move in opposite directions both in the case of temporary tariffs imposed in period 1 and the case of temporary tariffs anticipated for period 2**.

Consider now the more general case where investment uses imported capital goods ($\phi < 1$) and a tariff is levied on them too.This case is straightforward: investment falls more because tariffs now have a direct negative impact on the cost of capital in addition to the impact through the first period real appreciation:

$$\frac{\partial I}{\partial dt_1} = \frac{1-\phi}{\delta^* r_{kk}} < 0 \tag{45}$$

So we get an even larger trade surplus when $\phi < 1$ compared to when $\phi = 1$ because of a larger fall in investment. And when $\phi < 1$ we now also get a trade surplus in period 1 even with permanent tariffs, because of falling investment in period 1:

$$\frac{dP}{d\tilde{t}}|_{C+I} < \frac{dP}{d\tilde{t}}|_{C} = \frac{dp}{d\tilde{t}}|_{C} < \frac{dp}{d\tilde{t}}|_{C+I} \tag{46a}$$

$$\frac{dTB}{d\tilde{t}}|_{C+I} > \frac{dTB}{d\tilde{t}}|C = 0 \tag{46b}$$

To sum up, the larger trade surplus for the case $(C + I)$ compared with C comes about because investment falls more than when investment is not affected directly by first period tariffs. This impact is partially offset by less savings: a smaller real appreciation in period 1 leads to a larger shift of consumer expenditure towards period one. But this can only partially offset the effect of the larger fall in investment, otherwise the smaller real appreciation would not occur to begin with so we still get a larger trade surplus than in the $\phi = 1$ case.]

Temporary tariffs also produce a larger trade surplus in the (C+I) case than in the (C) case, again because investment falls more: when $\phi < 1$ the cost of investment goods goes up directly after imposition of a tariff on capital goods imports, by $(1 - \phi)dt_1$ which adds to the impact of a first period increase in the real exchange rate on the costs of investment.

3.4 Tariffs on intermediate imports

Consider now tariffs not just on consumption and capital goods imports but also on intermediate imports (think of oil, or steel during the recent US wave of tariffs). This case is of obvious practical relevance because for most countries intermediate imports make up about half of total imports.

We can incorporate intermediate imports into our model by using the expanded revenue function $R(P, Q; K, L)$ instead of $R(P; K, L)$, with $R = PX - QZ$ and $Z = -R_Q$. $Q = (1+t_1^{Int})Q^*$ is the first period price of intermediate imports Z, call them oil for brevity's sake. We can similarly extend the definition of the second period revenue function r with q, the second period oil price. We assume that the intermediate input with intertemporal price vector $[Q^*, \delta^* q^*]$ is not produced domestically and that the world price vector of intermediate goods is not affected by the tariffs, i.e. we assume complete forward shifting of the tariff on intermediate imports.

The model equations are the same as in equations 35 except that R and r now depend on $Q = Q^*(1+t_1^{Int})$ and $q = q^*(1 + t_2^{Int})$ also. As before the welfare effects of relative price changes can be derived by differentiating the ITBC, now using the expanded definition of R to incorporate intermediate imports and again evaluated around the zero tariff equilibrium:

$$E(\Pi(P,1),\Pi(p,1);U) = R(P,Q;K,L) + \delta^* r(p,q;K+I,L) - \Phi(P,f_1)I \tag{47a}$$

$$=> \tag{47b}$$

$$E_U dU = E_P^* dP + E_p^* \delta^* dp - Z dQ - z\delta^* dq \tag{47c}$$

where we assume that investment is at its pre-tariff-shock optimum, so $\delta^* r_k = \Phi$, which means terms related to dI to drop out in equation 47a due to what amounts to an envelope theorem.

Consider now the impact of changing first and second period tariffs t_1, t_2, around a zero tariff equilibrium, but this time on both final and intermediate imports. To simplify the analysis we assume $\phi = 1$, capital goods are entirely produced from home goods and so there are no capital goods imports. We proceed in two steps. First, step 1: analyse the impact of tariffs on intermediates assuming investment I fixed. And in step 2 analyze the same question but now with investment endogenized. The equations below introduce investment as a shock but do not yet endogenise it, to facilitate our two-step analysis:

$$(R_{P,P} - \Sigma_{P,P})dP - (\Sigma_{P,p})dp = E_{P,f_1} dt_1 + E_{P,f_2} dt_2 - [R_Q dt_1^{Int}] + [dI] \tag{48a}$$

$$-\Sigma_{p,P} dP + (r_{p,p} - \Sigma_{p,p})dp = E_{p,f_1} dt_1 + E_{p,f_2} dt_2 - [r_q dt_2^{Int}] - [r_k dI] \tag{48b}$$

With as solution, again with the impact of oil price changes in red:

$$\frac{dP}{d\tilde{t}} = \frac{\Sigma_{p,P}(E_{p,f_1} + E_{p,f_2} - [r_q dt_2^{Int}] - [r_k dI])) - \Sigma_{p,p}(E_{Pf_1} + E_{P,f_2} - [R_Q dt_1^{Int}] + [dI])}{\Delta} \tag{49a}$$

$$\frac{dp}{d\tilde{t}} = \frac{\Sigma_{p,P}(E_{P,f_1} + E_{P,f_2} - [R_Q dt_1^{Int}] + [dI])) - \Sigma_{P,P}(E_{pf_1} + E_{p,f_2} - [r_q dt_2^{Int}] - [r_k dI])}{\Delta} \tag{49b}$$

$$=> \frac{\delta_c}{d\tilde{t}} = \frac{dP}{d\tilde{t}} - \frac{p}{d\tilde{t}} = 0 \tag{49c}$$

For the analysis with investment fixed ($I = \bar{I}$), we can simply set the terms dI in equations (48) equal to zero so the terms $dI, r_k dI$ in equations 48 and 49 drop out. Furthermore if we assume equal shock incidence across periods ($R_Q = \delta * r_q$) [14], equation (49c) shows that we again get that a permanent tariff will not change intertemporal relative prices δ_C^*.

Equations 49 show that under the usuall symmetry conditions the real appreciation will be the same in each period, although larger than in the case with tariffs on C-goods only. This is because tariffs on intermediate imports lead to a decline in output in both periods. The impact on goods markets is therefore similar but larger than when tariffs are only levied on imported consumer goods: in the set-up of equations 48 it is clear that the tariffs on intermediate goods simply show up as a larger shock to the respective final home goods markets for $dt_1, dt_1^{Int} > 0$:

$$E_{P,f_1} dt_1 - R_Q dt_1^{Int} > E_{P,f_1} dt_1 \tag{50}$$

[14] cf footnote10

Therefore the results for the real exchange rate response today and tomorrow, listed in equations (49) are very similar to what we got in from Section 3.2 except larger:

$$\frac{dP^{C+\bar{I}}}{dQ} = \frac{dp^{C+\bar{I}}}{dq} > \frac{dP^{C}}{dQ} = \frac{dp^{C}}{dq}. \tag{51}$$

The real appreciation is larger in each period than it is in the final goods only case because aggregate supply falls in both periods when tariffs on intermediate goods are also raised.

But endogenizing investment will once again change the results compared to the case with investment unchanged as is clear from equations (49) by inspecting the terms with dI. Consider first the partial impact of tariff-induced higher domestic oil prices on investment for *given* real exchange rate today (P) and tomorrow (p). Under the simplifying assumption of $\phi = 1$, oil is not used directly in producing investment goods, so the aggregate cost of investment Φ is not directly affected by the tariffs on intermediate imports, only through their impact on P, p and from there on Φ. But the second period return on capital r_k *is* directly affected by second period intermediate goods prices because $r_{k,q} < 0$, so for given P, p investment does fall on impact after higher tariffs on intermediate goods trigger $dQ, dq > 0$:

$$\frac{\partial I}{\partial q} = -\frac{r_{k,q}}{r_{k,k}} < 0 \tag{52}$$

Note the differential impact of a fall in investment on first and second period commodity markets. A fall in investment *reduces* upward pressure on the first period exchange rate since a component of demand goes down (the term dI in equation 48a). We thus get a lower real appreciation in the first period:

$$\frac{dP^{C+I+Int}}{dQ} < \frac{dP^{C}}{dq} \tag{53}$$

But a decline in investment *increases* the real appreciation in the second period because a lower period 2 capital stock leads to a reduction in aggregate supply in the second period (the term $r_k dI$ in equation 48b:

$$\frac{dp^{C+I+Int}}{dQ} > \frac{dp^{C}}{dq} \tag{54}$$

By inserting the investment response from equation equation 52 into the solutions listed in equation52 we therefore get that, contrary to the exogenous investment case, an oil-like shock induced by tariffs on imported intermediates in both periods and with endogenous investment leads to a smaller appreciation today but a higher real appreciation tomorrow than what we get in the same setup but with investment fixed. This is because endogenizing investment reduces pressure on the first period real exchange rate because less investment leads to less demand for home goods in the first period (cf the negative term dI in equation **??**).

This negative demand impact is different from what is highlighted in the literature on oil price shocks: there the negative demand effect arises because of the income effect of an external oil price shock (cf van Wijnbergen (1985) among many others). That does not happen here because we assume that tariff revenues are handed out again in lump sum fashion, eliminating the negative income effect. But downward pressure on P emerges nevertheless: the induced fall in investment lowers pressure on first period domestic goods prices P to the extent that investment uses domestic goods ($\phi > 0$):

$$\frac{dP}{d\tilde{t}}|_{C+I+Int} < \frac{dP}{d\tilde{t}}|_{C+I} = \frac{dp}{d\tilde{t}}|_{C+I} \tag{55}$$

There are no (partially) offsetting AS en AD effects on the second period exchange rate: output and investment effects now reinforce each other. Second period output falls both because of the direct impact of q on r_p and because the second period capital stock goes down with higher q. As a consequence the second period real exchange rate appreciates more than in the first period and the intertemporal terms of trade deteriorate as a consequence: future goods become unambiguously more expensive than current goods even when tariffs are permanent: the impact on the intertemporal terms of trade $\frac{\Pi(P,f_1)}{\delta^* \pi(p,f_2)}$ is unambiguously negative:

$$\frac{dp}{d\tilde{t}}|_{C+I+Int} < \frac{dp}{d\tilde{t}}|_{C+I+Int} \tag{56}$$

$$=> \frac{\delta_C}{d\tilde{t}}, \frac{\delta_I}{d\tilde{t}} < 0 \tag{57}$$

For given investment we thus again get a zero trade balance result since with $R_Q = r_q < 0$ there will be an equal real appreciation in both periods and by assumption no investment response since we assumed $I = \bar{I}$ and thus no shift in relative intertemporal prices. But with endogenous investment, intertemporal relative prices do change, future goods become relatively more expensive than goods today. Also we saw that the shift of consumer expenditure towards today has to fall short of the impact on teh real exchange rate of the investment response, otherwise the deterioration of the intertemporal terms of trade would not occur to begin with. So we can conclude that with endogenous investment the first period trade balance actually deteriorates even when tariffs are permanent:

$$\frac{dTB}{d\tilde{t}}|_{C+I+Int} > 0 \tag{58}$$

The trade balance improves but because of a fall in investment. Note that with endogenized investment the fall in investment will be larger than in the case with endogenous investment but without intermediate goods. Accordingly we can summarise the results on the impact of permanent tariffs on the the trade balance as follows:

$$\frac{dTB}{d\tilde{t}}|_{C+I+Int} > \frac{dTB}{d\tilde{t}}|C+I > \frac{dTB}{d\tilde{t}}|C=0 \tag{59}$$

4 Tariffs and Unemployment

Consider finally the impact of tariff policy on unemployment. In line with the disequilibrium literature cited earlier and more recent suggestive empirical evidence (cf Lorenzoni and Werning (2024), we consider two disequilibrium variants. In the first "classical unemployment" or "CU" variant, first period wages are indexed to the first period consumer price index Π which results in a real product wage ω too high to clear the labor market. Prices P do adjust to clear first period commodity markets and second period wages always clear second period labor markets.

The second variant covers Keynesian unemployment, where temporary price rigidity triggers a shortfall of effective demand compared to current output supply: i.e. the real exchange rate P is at a level too high for (home) goods market clearing.

4.1 Real Wage Resistance and Classical Unemployment

Consider first supply constrained unemployment, where first period unemployment is triggered by real wage indexation on the consumption wage in that period. Through the indexation mechanism, any change to the cost of the consumption basket triggers wage adjustments to restore the real consumption wage to its pre-contracted level. The real consumption wage does not adjust to shocks within the period where these shocks occur, but prices do adjust to continuously clear the market for home goods. We analyze the case where the real product wage that comes out of the indexation mechanism is too high to clear the labor market.

Labor demand depends on the real product wage $\omega = W/P$, which, when classical unemployment prevails, is above the full employment real product wage:

$$CU : R_L(1, \omega; K, 1) < \omega \tag{60}$$

$$=> \ R_\omega(1, \omega; K, L) < 1 \tag{61}$$

To incorporate disequilibrium in the model we introduce a virtual real wage, $\tilde{\omega}$: $\tilde{\omega}$ is the real wage that would increase demand for labor to its full employment level. An increase in the real product wage given everything else leads to a widening of the gap between virtual and actual real product wages and accordingly to a corresponding decline in employment/increase in unemployment. Formally all this is summarized in equations 62:

$$R_\omega(1, \tilde{\omega}; ..) = 1 \tag{62a}$$

$$=> \tilde{\omega} \leq \omega \ when \ L \leq 1, \ \frac{\partial(\omega - \tilde{\omega})}{\partial \omega} > 0 \tag{62b}$$

$$\frac{\partial L}{\partial \omega} = R_{LL}^{-1} < 0 \tag{62c}$$

Prices are flexible so commodity markets clear and consumers (domestic and foreign) will just absorb the reduced level of home goods produced at the excessive real product wage $\omega > \tilde{\omega}$. [15]

So now consider the case of the tariffs being introduced in this classical unemployment environment. Real consumption wages are contracted at the beginning of period one before the tariffs are imposed. Real wage indexation ties changes in the real product wage to changes in the cost of living Π so as to keep the real consumption wage constant, with an increase in the real product wage as a result:

[15] Note that in the original disequilibrium literature classical unemployment assumes both rigid wages and rigid prices (see Barro and Grossman (1976) and Malinvaud (1977)). Under Malinvaud/Barro style classical unemployment, consumers are rationed at the prevailing real exchange rate to match the reduced level of aggregate supply.

$$W = \gamma\Pi \tag{63a}$$

$$dW = (1-\phi)dP + \phi dt_1 \tag{63b}$$

$$=> dW - dP = \phi(dt_1 - dP) > 0 \tag{63c}$$

So if first period real consumption wages are fixed in period 1, higher tariffs on consumption goods immediately lead to higher real product wages when real consumption wages are fixed at their contracted value: the real product wage needs to increase to maintain the real consumption wage at its contracted value when tariffs increase the cost of imported consumption goods. [16]

Combining equations 63 and 62 we get that under real wage indexation on the consumer price index Π, a higher tariff on imported consumption goods will both push up the real product wage and trigger a fall in labor demand and unemployment:

$$\frac{dL}{dt_1} = \frac{dL}{d(W/P)}\frac{d(W/P)}{dt_1} \tag{64a}$$

$$= R_{LL}^{-1}\phi(dt_1 - dP) < 0 \tag{64b}$$

Tariffs on intermediate imports do not directly effect the real product wage but they have a similar initial impact on the virtual wage gap because they will lead to a lower virtual wage $\tilde{\omega}$ when labor and oil are strategic complements (i.e. when $R_{Q,L} < 0$). It immediately follows from equation 62a that tariffs on intermediate imports will decrease the virtual real product wage, increase the virtual wage gap $\omega - \tilde{\omega}$ and as a consequence trigger a rise in unemployment also.

To assess the impact on the Trade Balance we need to go through the ITBC again, now taking L-market disequilibrium into account. We adjust equation 3.2 for labor market disequilibrium and thus a wedge between the actual and the virtual real product wage):

$$E(\Pi, \pi; U) = R(P, Q; K, L(\tilde{\omega})) + L(\omega - \tilde{\omega}) \;\; => \tag{65a}$$

$$E_U dU = E_P^* dP + E_p^* \delta^* dp + R_L R_{LL}^{-1}\phi(d\tilde{t} - dP) - Z dQ - \delta^* dq \tag{65b}$$

As before we only consider first period surprises, second period tariffs are preannounced at the beginning of the first period. As a consequence full employment prevails in the second period, but current shocks occurring after the wage contracts are concluded at the beginning of period 1 will throw the economy out of full employment. An immediate result is that permanent tariffs on consumption and intermediate goods imports will only trigger temporary unemployment today. This has consequences for the trade balance response: tariff induced unemployment triggers a temporary decline in employment and thus in first period income. Expenditure

[16] We do assume that the Metzler paradox (cf Metzler (1949)) does not prevail, i.e. $dt_1 - dP > 0$ in the post-tariff-increase equilibrium. See Dixit and Norman (1980) for a discussion of this anomaly.

smoothing then leads to downward pressure on the trade balance even in the case of permanent tariffs $d\tilde{t} > 0$ (the first term in equation 66b:

$$\frac{dTB_1}{d\tilde{t}}|_{CU} = \frac{dTB_1}{d\tilde{t}}|_C + R_L R_{LL}^{-1}(1 - \frac{E_{\Pi,U}}{E_U})(d\tilde{t} - dP) - \Pi E_{\Pi,\delta_c}\frac{d\delta_c}{d\tilde{t}} \tag{66a}$$

$$= \underbrace{(1 - mc_\Pi)R_L R_{LL}^{-1}(d\tilde{t} - dP)}_{-} \underbrace{-\Pi E_{\Pi,\delta_c}\frac{d\delta_c}{d\tilde{t}}}_{+} < 0 \text{ if intertemporal substitution effects are small} \tag{66b}$$

Against that works that, if real wage pressure reduces first period output, we also get a further real appreciation, to balance consumption demand with the reduced output. As a consequence δ_c decreases more in the classical unemployment case than in the full employment case after a permanent tariff increase. This leads to substitution from expenditure today towards tomorrow, and a partially offsetting improvement in the trade balance (the second term in equation 66b).

Summing up: if we once again rule out the Metzler paradox (i.e. we rule out $d\tilde{t} - dP) < 0$) and intertemporal substitution effects are small, we get that permanent tariffs may in fact lead to higher unemployment and a deteriorating trade balance rather than to the improvement in both that tariff-promoting politicians predict.

4.2 Exchange Rate Overvaluation and Keynesian Unemployment

Under Keynesian unemployment, goods markets do not clear: at prevailing prices demand falls short of supply in the home goods market, the exchange rate P is overvalued. Since there is excess aggregate supply, adding a supply shock through intermediate imports does not add much so we consider the case without intermediate imports and accordingly without dQ, dq.

NEW VERSION In the region of Keynesian unemployment, the commodity market clearing equation changes from the equilibrium version:

$$R_P(...) > X = E_P + E_P^* => dX = E_{Pf_1}dt_1 + E_{Pf_2}\delta^* dt_2 + (E_{P,\delta^* p} + mc_1 E*_p)\delta^* dp \tag{67}$$

Before assessing the expansionary impact of tariffs on first period output we need one auxiliary result that we can get by differentiating the second period commodity market clearing equation $r_p = E_p + E_p^*$:

$$\frac{dp}{d\tilde{t}} = -\frac{E_{p,f_1} + E_{p,f_2}}{E_{p,p+E_{p,p}^*+mc_2 E_p^*}} > 0 \tag{68}$$

Permanent tariffs will lead to a real appreciation tomorrow[17].

It follows that tariffs have an expansionary impact on first period output in a regime of Keynesian unemployment:

[17] As before we make the plausible assumption that the second period income effect of an appreciation is dominated by the direct within period substitution effects

$$\frac{dX}{d\tilde{t}} = \underbrace{E_{Pf_1}}_{A} + \underbrace{E_{Pf_2}}_{B} + \underbrace{mc_1 E *_p \frac{\delta^* dp}{d\tilde{t}}}_{C} \tag{69}$$

$$> 0 \tag{70}$$

Output (and therefore employment) in period 1 unambiguously go up because (A) tariffs today switch demand towards home goods today, (B) tariffs tomorrow switch demand from tomorrow towards today, part of which falls on home goods (B) en because of the positive income effects a tariff induced real appreciation tomorrow is partially spent today (C).

The next step is to derive the trade balance effects of higher tariffs:

$$\frac{dTB_1}{d\tilde{t}} = \underbrace{(1 - mc_I)\frac{dX}{d\tilde{t}}}_{\text{A}} - \underbrace{\Pi E_{\Pi,\pi}\frac{d\delta_C}{d\tilde{t}}}_{\text{B}} \tag{71}$$

The direct impact is positive: as we saw tariffs lead to higher first period output when Keynesian unemployment prevails, and part of that income gain is spent tomorrow leading to a trade surplus today (term (A) in equation (71) below). There is a potentially offsetting effect: by assumption $dP = 0$ under Keynesian unemployment but we show in equation (**??**) that there is a period 2 real appreciation, so the intertemporal terms of trade δ_C move against future goods (δ_C increases). This makes future goods more expensive and in itself triggers a decline in savings (the term above bracket (B). If we would have included domestically produced investment ($\phi = 1$), there would be a second potentially offsetting effect, the second period real appreciation will trigger an investment boom in period 1 which strengthens our output rfesults but moffsets positive impact on the trade balance. To sum up: under Keynesian unemployment higher tariffs will lead to higher first period output, employment and investment, and may lead to a positive trade balance impact of higher tariffs although the future real appreciation and higher investment we also get work in the other direction, making the overall trade balance effect uncertain even under Keynesian unemployment. Under real wage triggered unemployment, tariffs will lead to lower first period output and a deteriorating trade balance. Under Keynesian unemployment, output, employment and investment will gain from higher tariffs but the trade balance impact is ambiguous. Under no circumstance will the politicians' dream (higher output, employment, investment and an unambiguously improving trade balance) come out in repsonse to higher tariffs.

5 Conclusions

This paper has revisited an old question — do tariffs improve the trade balance and raise employment — using a framework better suited to the question than the static models that dominate the traditional trade-policy literature: an explicitly intertemporal, Mundell-Fleming-style setup that, unlike Razin and Svensson (1983) or van Wijnbergen (1987), allows tariffs to fall on intermediate and capital goods as well as on final consumption goods. Since intermediate and capital goods together account for roughly three-quarters of world trade flows,

this extension is not a technical nicety but a first-order correction to a literature that has effectively analyzed a quarter of the problem.

The existing literature on tariffs is largely static and focuses mostly on tariffs on consumer goods. Our basic point is that the macroeconomic consequences of tariff policies depend crucially on the type of goods over which tariffs are levied and on the time pattern of the tariffs imposed. To back up that claim we develop a simple intertemporal model to analyze how temporary and permanent tariffs on final, intermediate, and capital goods respectively affect the trade balance, investment and employment.

We show that under market clearing, the trade-balance effect of tariffs on consumer goods depends on whether they affect intertemporal relative prices. Intertemporal relative prices may change because tariffs increase more today than tomorrow or because the real exchange rate appreciates more today than tomorrow, both of which we analyse extensively. Permanent tariffs cause the real exchange rate to appreciate in both periods but leave intertemporal relative prices and thus the trade balance unchanged. Tariffs that are known to be temporary will improve the trade balance both directly and because they trigger a larger real appreciation today than tomorrow.

Endogenizing investment shows that when tariffs are levied on goods used for capital formation, trade-balance gains may occur, but when they do that happens by reducing capital formation; so trade balance improvement and an investment boom will not occur at the same time. The two objectives that trade-policy advocates typically list together — a smaller trade deficit and higher domestic investment — are mutually exclusive rather than complementary.

Permanent tariffs on intermediate goods (that make up about 50% of international trade) will immediately and permanently reduce output and income, but their trade balance impact is ambiguous. If today's fall in output is larger than tomorrow's, the trade balance will actually deteriorate because of the tariffs. An offsetting effect occurs because tariffs on intermediate imports will also reduce the marginal productivity of capital and therefore lead to a fall in investment, which tends to improve the trade balance.

The consequences of tariff policies in the presence of unemployment depend on what is the root cause of that unemployment. Under classical unemployment (first period real wage resistance), tariffs will lead to higher real product wages and higher first period unemployment, so the trade balance will in fact deteriorate. The only setting in which the political intuition is vindicated is an environment of Keynesian unemployment, where prices are temporarily rigid and output is demand-constrained: then tariffs on final goods switch demand to "our goods" and may improve the trade balance simultaneously. But even in a Keynesian unemployment regime the trade balance impact is by no mmeans certain; intertemporal substitution effects triggered by a future real appreciation and a possibly positive impact on first period investment lead the trade balance to deteriorate.

Taken together our results suggest that the burden of proof for tariff-based trade policy is considerably higher than is usually acknowledged. Outside of a Keynesian slack environment, tariffs are at best neutral for the trade balance and at worst counterproductive, and any trade-balance gains that do materialize tend to come at the cost of investment rather than alongside it. Extending the analysis to retaliation and trade-war dynamics, to the interaction between tariff policy and monetary policy (deliberately set aside here), and to an empirically calibrated version of the model capable of speaking to the magnitudes involved in the 2025 U.S. tariff episode, are natural next steps. Finally a two-country extension of the model would allow for the analysis of backward

shifting of tariffs and the link between tariffs and world interest rates.

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